MECHANICAL ENGINEERING

November 1960

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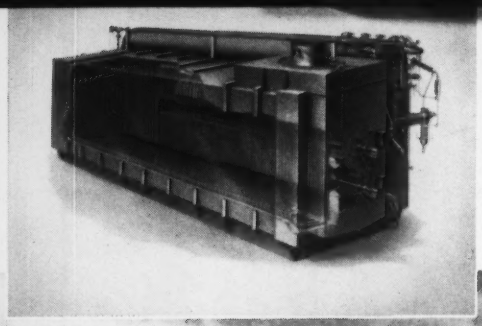

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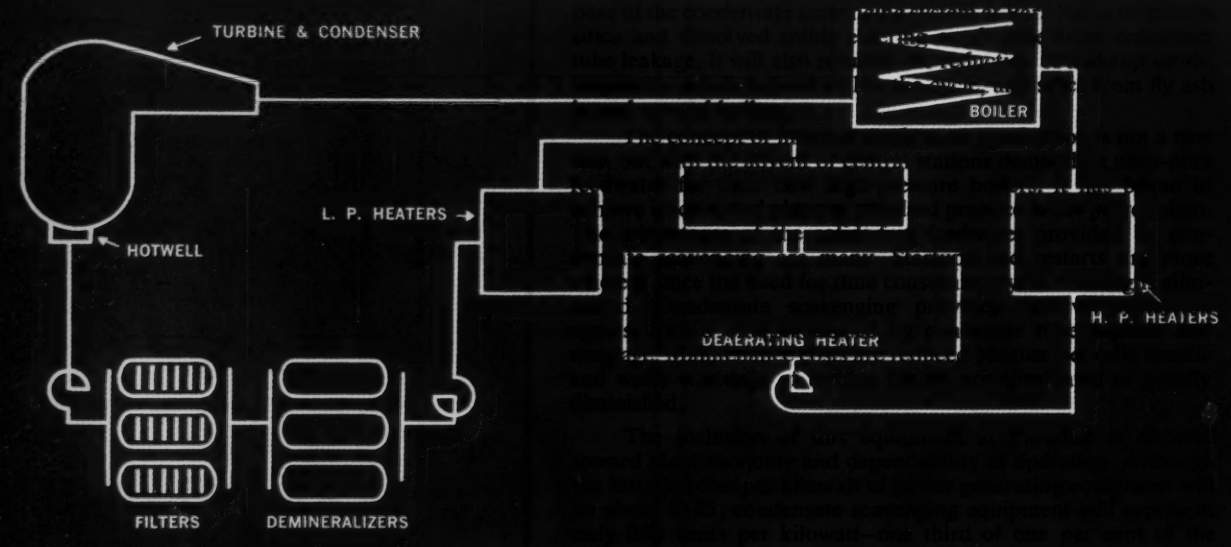

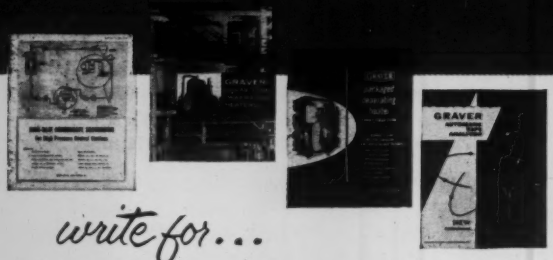

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This is the new Bergen Generating Station of New Jersey's Public Service Electric and Gas Company. Installed capacity: 580,000 kw. Basic fuel: coal. Public Service, whose electric system ranks in the upper 10 among some 400 private U. S. producers of electricity, purchased the property over 30 years ago, recognizing the growth potential of their Northern New Jersey area. Their stations are a part of the Pennsylvania—New Jersey—Maryland interconnection, having total capacity of 14 million kw. See pp. 80-81.

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The men you supervise: Is their performance merely "adequate," or do they give you their best? Today, you need to understand men's social, ego, and self-fulfillment needs. The word is "motivation."

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They started with a clean slate. The machine, the tools, and the tool holders were developed together, a study in "interdenominational" co-operation, with results superior to any divided approach.

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On Oct. 4, 1957, Russia sent into space the earth's first artificial satellite. Where do we stand, today, in the exploration of space? Can the returns be foreseen? Here's the word, direct from NASA.

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How are decisions made on plant expansion? What do leaders foresee in efficiency, automation, nuclear reactors? When anyone inquires where we're headed on power, refer him to this group of articles. Here are the industry's probable directions.

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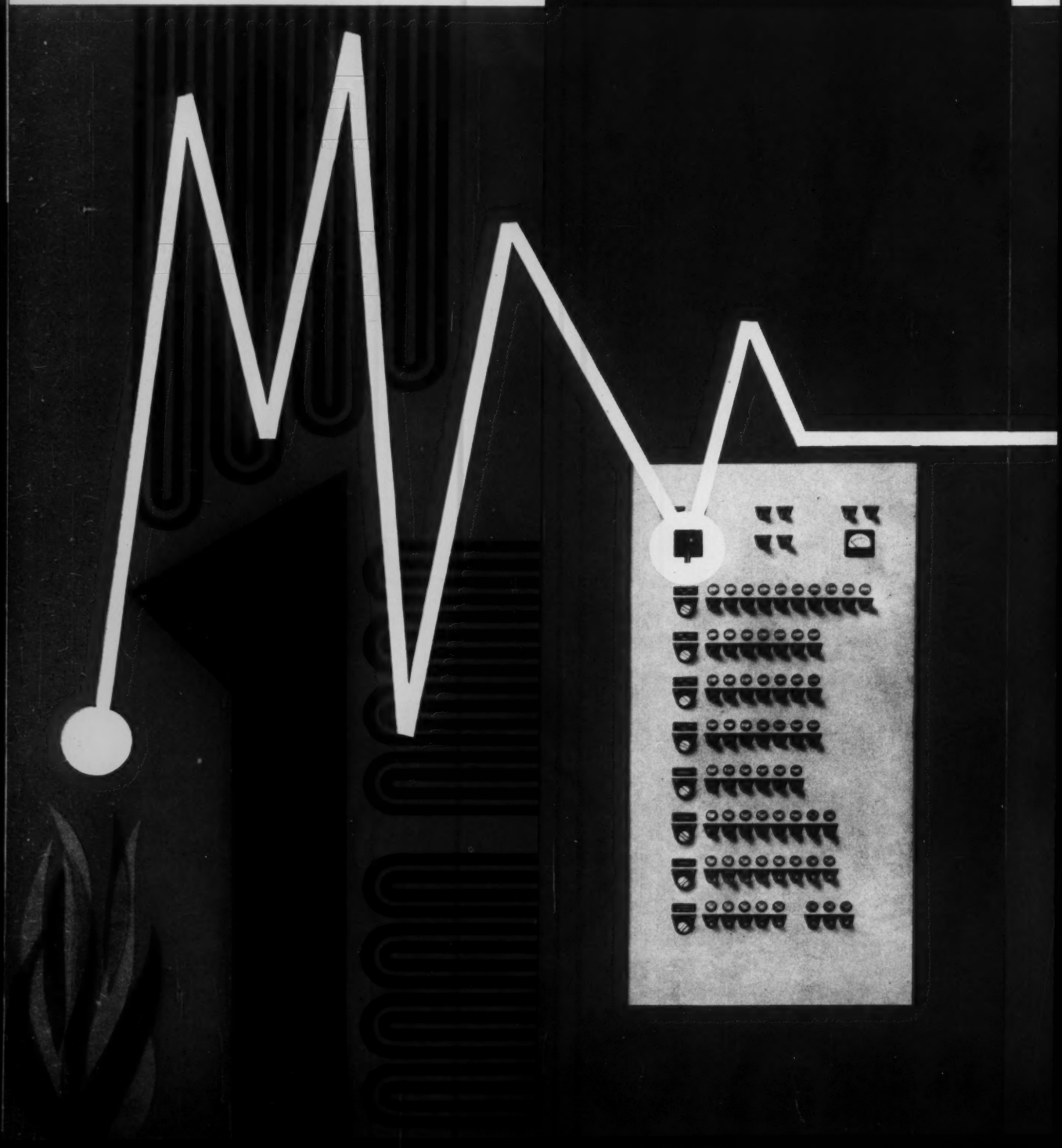

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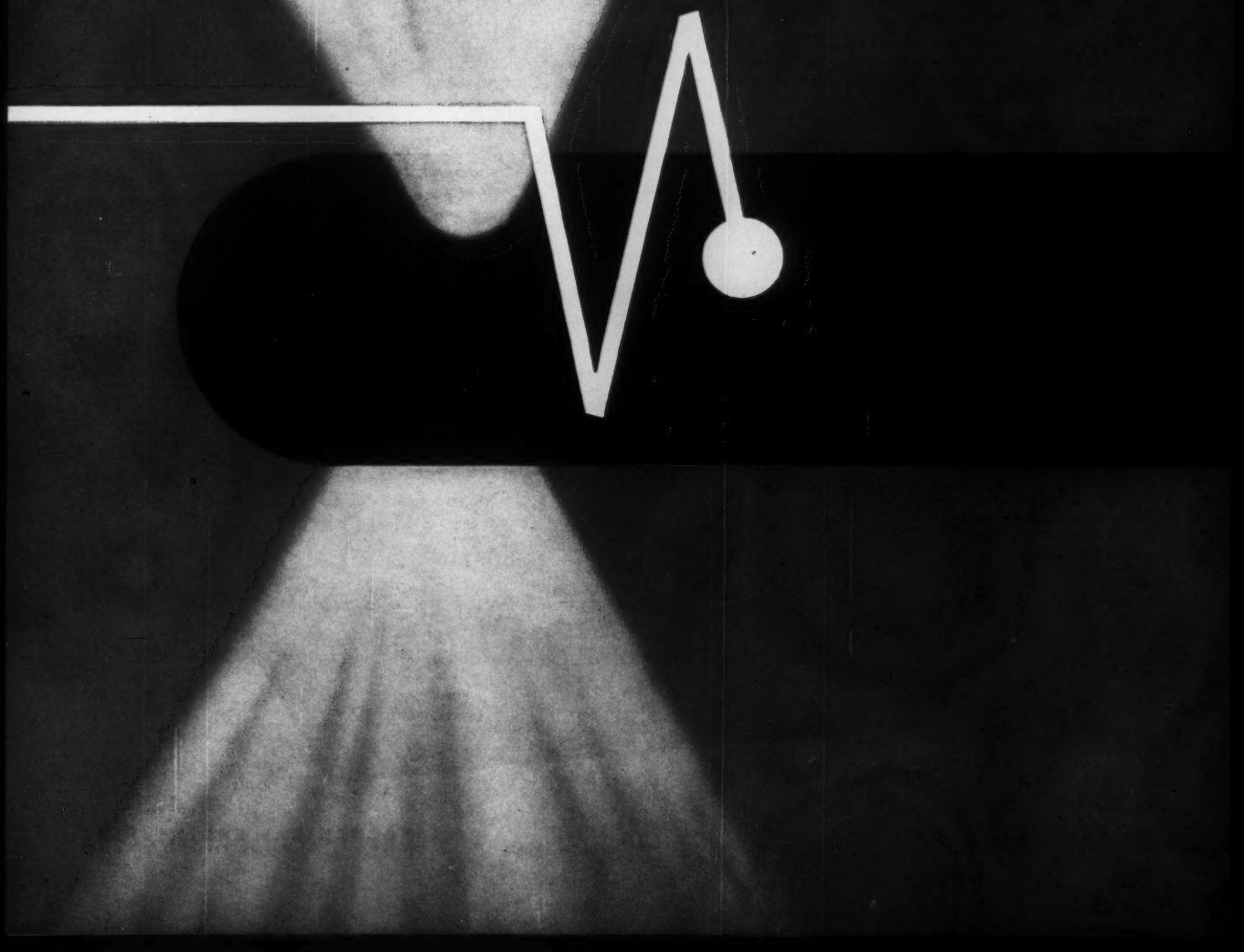

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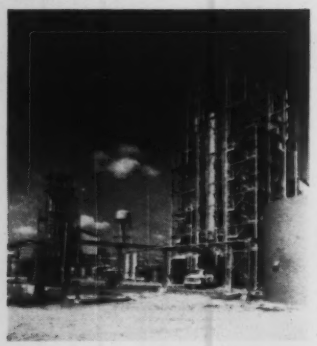
The P-K HEAT EXCHANGER Manual is a new 108-page work book that makes selection of a heat exchanger far easier than ever before. It enables you and your engineering staff to save time, effort and duplication of work in developing a design that will meet all your performance conditions.

This new work book standardizes terminology. It illustrates and describes components commonly used in processing. It groups interchangeable front heads, shell sections and rear heads. In much the same way, it groups standard gasket joints, tube pass partitions and shell baffles, thus greatly sim-



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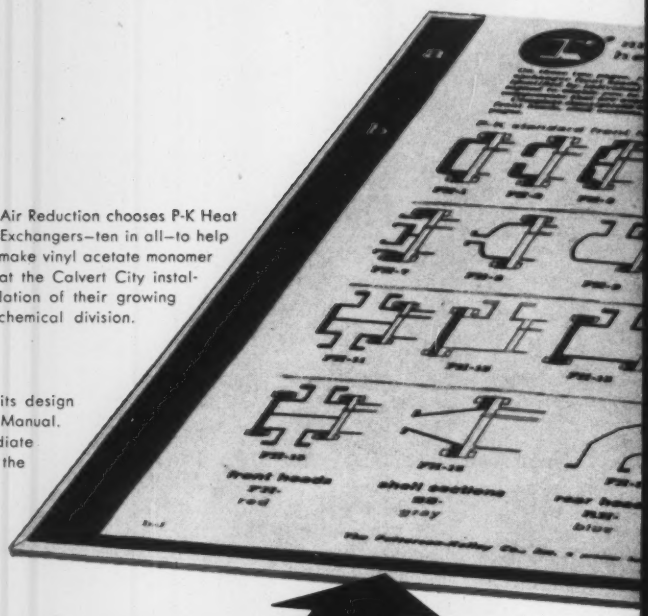
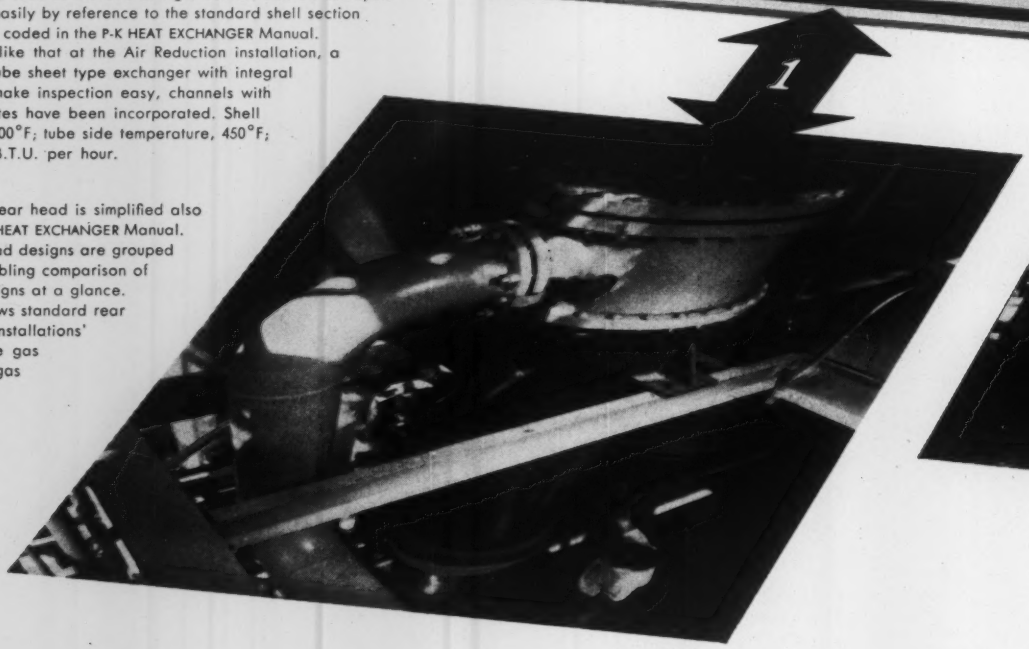


❶ Which type front head for your heat exchanger? You can "pinpoint" its design more quickly by reference to the head coding index in the new P-K HEAT EXCHANGER Manual. In the Air Reduction installation four P-K exchangers of the type at the immediate right cool crude product gas in the tube side by means of water flow through the shell side. Tube temperature is 300°F; shell temperature 150°F; capacity, 581,000 B.T.U. per hour.

❷ Shell sections, such as the one at right center, can be surveyed and specified more easily by reference to the standard shell section designs grouped and coded in the P-K HEAT EXCHANGER Manual. There are four units like that at the Air Reduction installation, a straight tube, fixed tube sheet type exchanger with integral expansion joint. To make inspection easy, channels with removable cover plates have been incorporated. Shell side temperature is 300°F; tube side temperature, 450°F; capacity is 580,000 B.T.U. per hour.

❸ Selection of rear head is simplified also when you use the P-K HEAT EXCHANGER Manual. Twenty-eight rear head designs are grouped and coded here, enabling comparison of the most popular designs at a glance. Photo at far right shows standard rear head on one of the installations' two refrigerated type gas cooler and liquid-to-gas heat exchangers.



plifying the underlying details of design.

In other sections of the P-K HEAT EXCHANGER Manual you find an outline of the economic and performance advantages of principal designs, a review of the fundamentals of heat transfer, and a number of basic tables and formulas, along with a comprehensive design check list and other features.

As significant developments occur, the P-K HEAT EXCHANGER Manual will be supplemented and the new material sent to registered holders.

Available copies of this useful new manual are limited in number, and therefore are reserved primarily for those in the process industries who can best apply the information. If you design or specify heat exchangers, you are invited to write to us on your company letterhead, outlining briefly the areas of your interest. A few copies are available to students and non-technical personnel at a nominal charge. The Patterson-Kelley Co., Inc., 990 Burson Street, East Stroudsburg, Pa.

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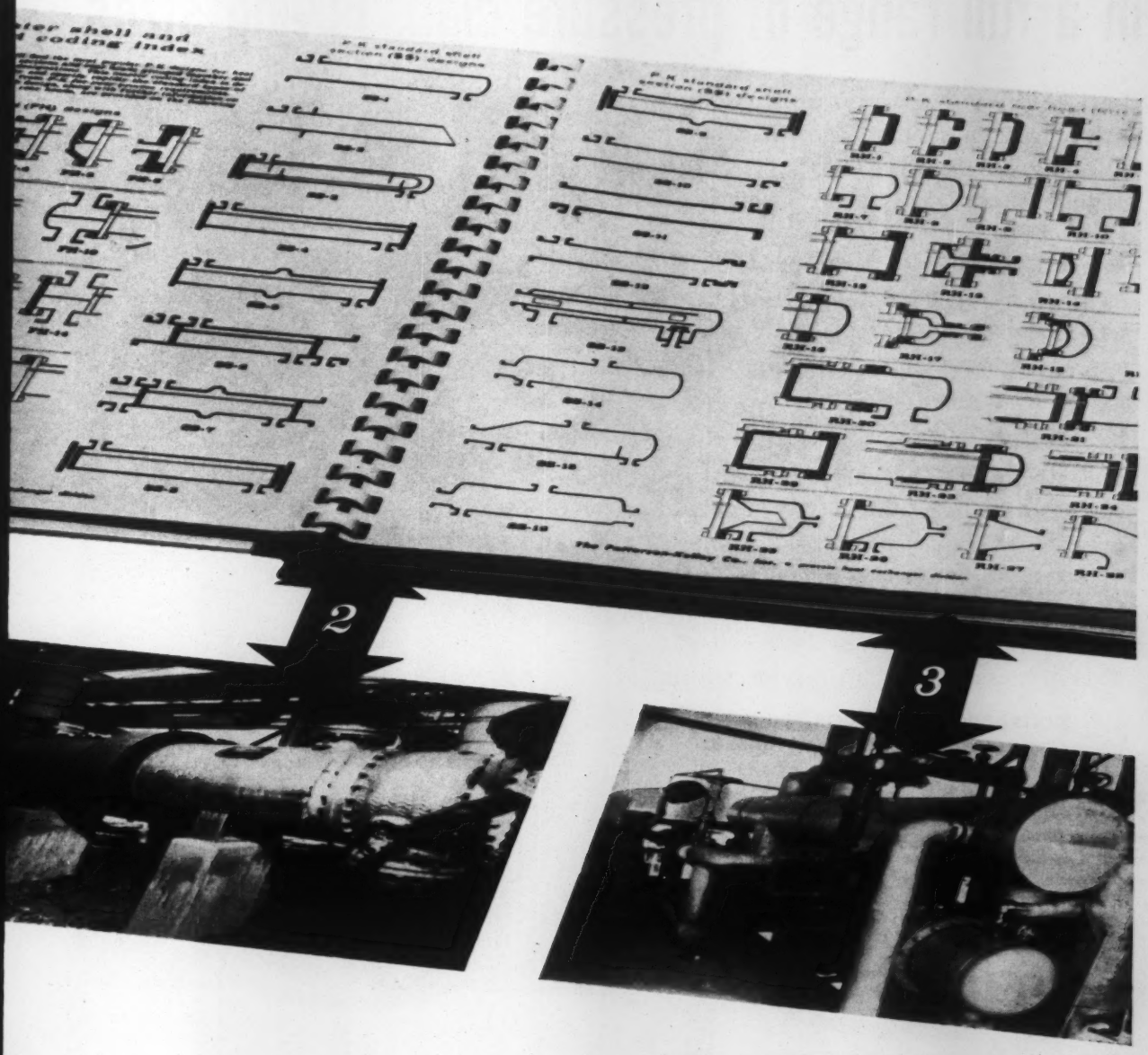

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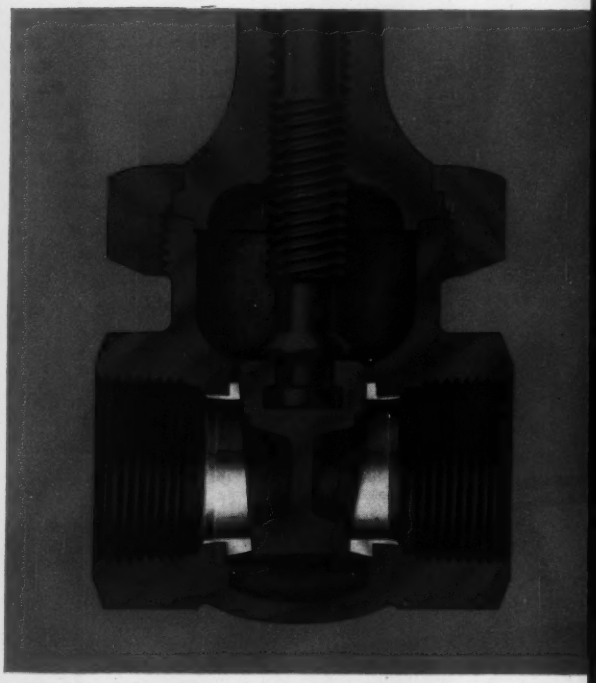

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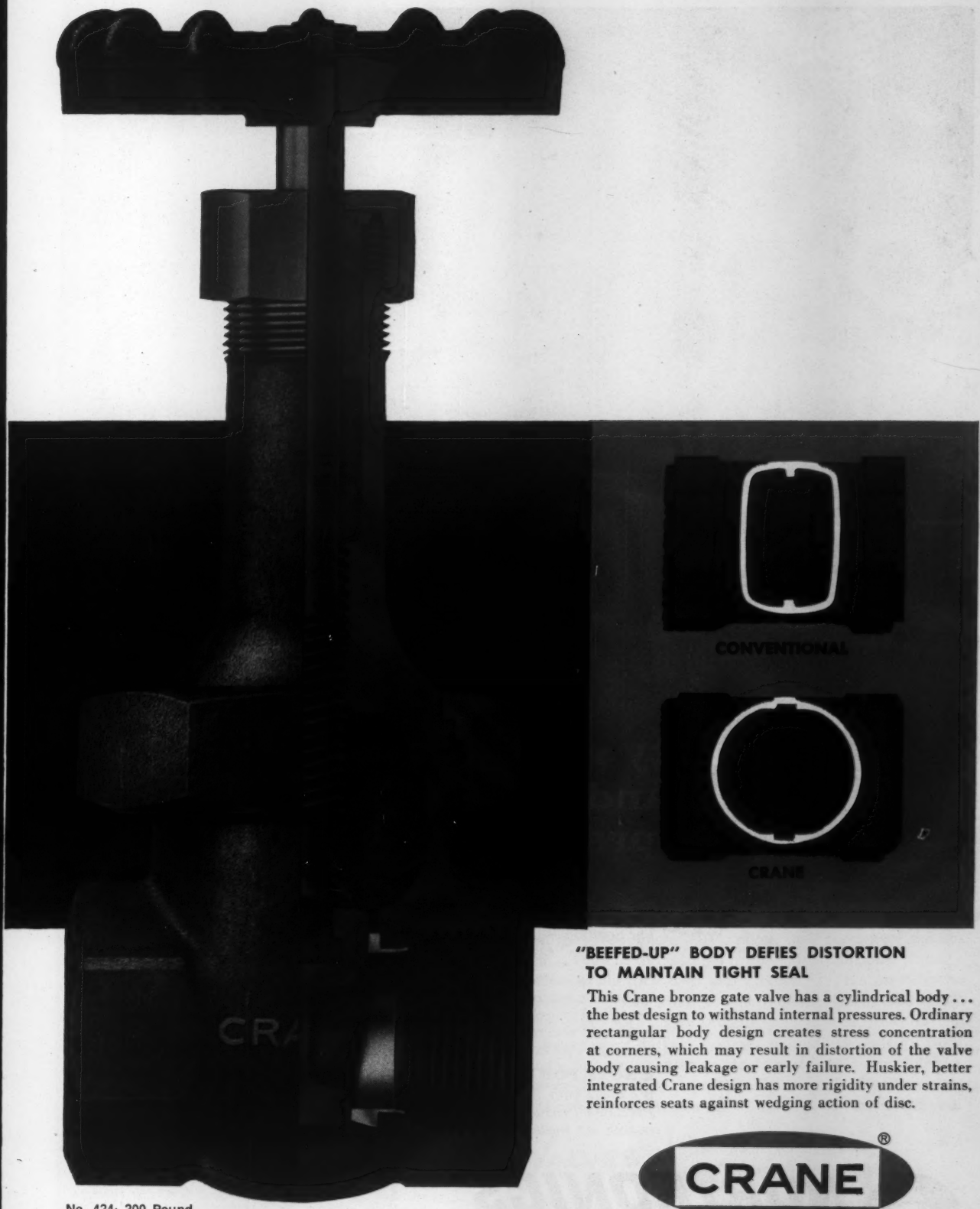

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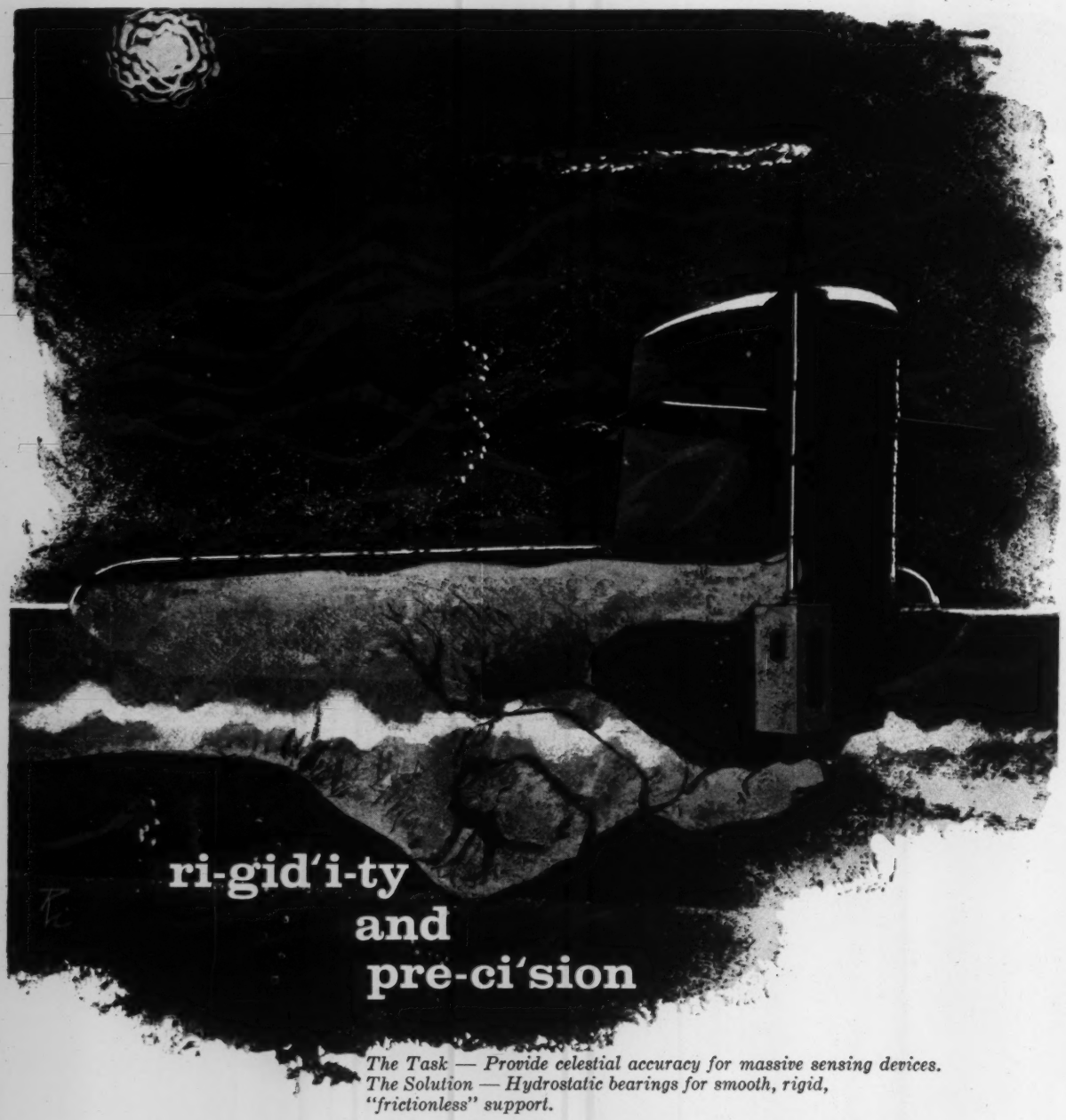

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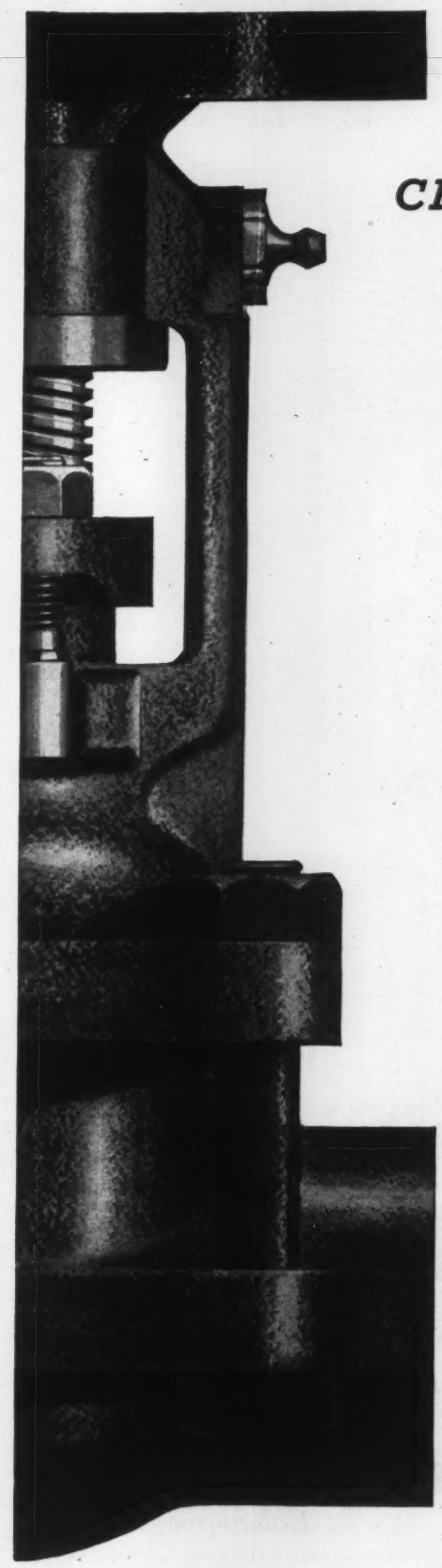


CHECK OIC FIRST...IT PAYS!

DEPENDABILITY is the *first* consideration when you choose a valve, because the cost of valve failure in down time is almost always greater than the cost of the valve itself. That's why so many of the best distributors sell the OIC line. They know that when they recommend OIC valves, their customers can depend upon them...even in those tough problem installations. Equally important is the distributor's own dependability... his capacity to deliver the valves you need, when you need them. Here, OIC offers the support of a complete factory inventory of bronze, iron, ductile iron, cast and forged-steel valves. You get immediate delivery from your OIC distributor's representative stock, and 4 to 5-day delivery from warehouse or factory. For dependability of product and service, phone your OIC distributor. He has our all-out support in serving you.

OIC VALVES

FORGED AND CAST STEEL, BRONZE, IRON AND DUCTILE IRON VALVES

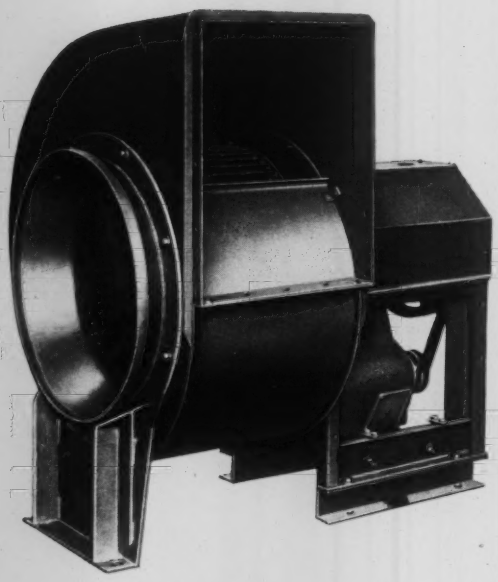
THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

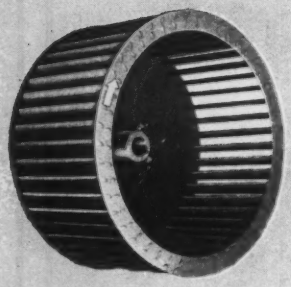
CLARAGE

New line of

V-belt driven

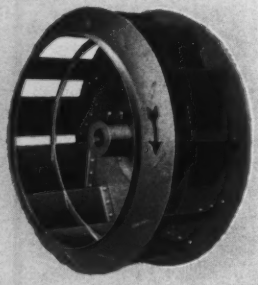
Ready Units





LS Ready Units have Low Speed, forward curved blade wheels. These are of the long-recognized Clarage Type HV multiblade design.

or



MS Ready Units have Medium Speed, backward inclined blade wheels with non-overloading horsepower characteristic. These are of the highly regarded Clarage Type NH, Class I design.

Exceptionally sturdy, quiet, ready-to-run fan sets

- for volumes up to 25,000 CFM
- for static pressures thru 2½"
- for clean air up to 300° F.

Distinguishing points — over 15 of them — make these new Clarage units outstanding.
To mention a few: Better motor ventilation . . . entire drive within frame of unit . . . complete accessibility to motor, drive, and bearings. Learn more about the numerous specific advantages that mean greater value to you from Clarage. Request Catalog 517 . . . 36 pages of complete information, selector charts, capacity tables, dimensions. Clarage Ready Units are ideally suited for supply or exhaust jobs — indoors or outdoors — for buildings of all types, all sizes.

Write for your Copy

Dependable equipment for making air your servant

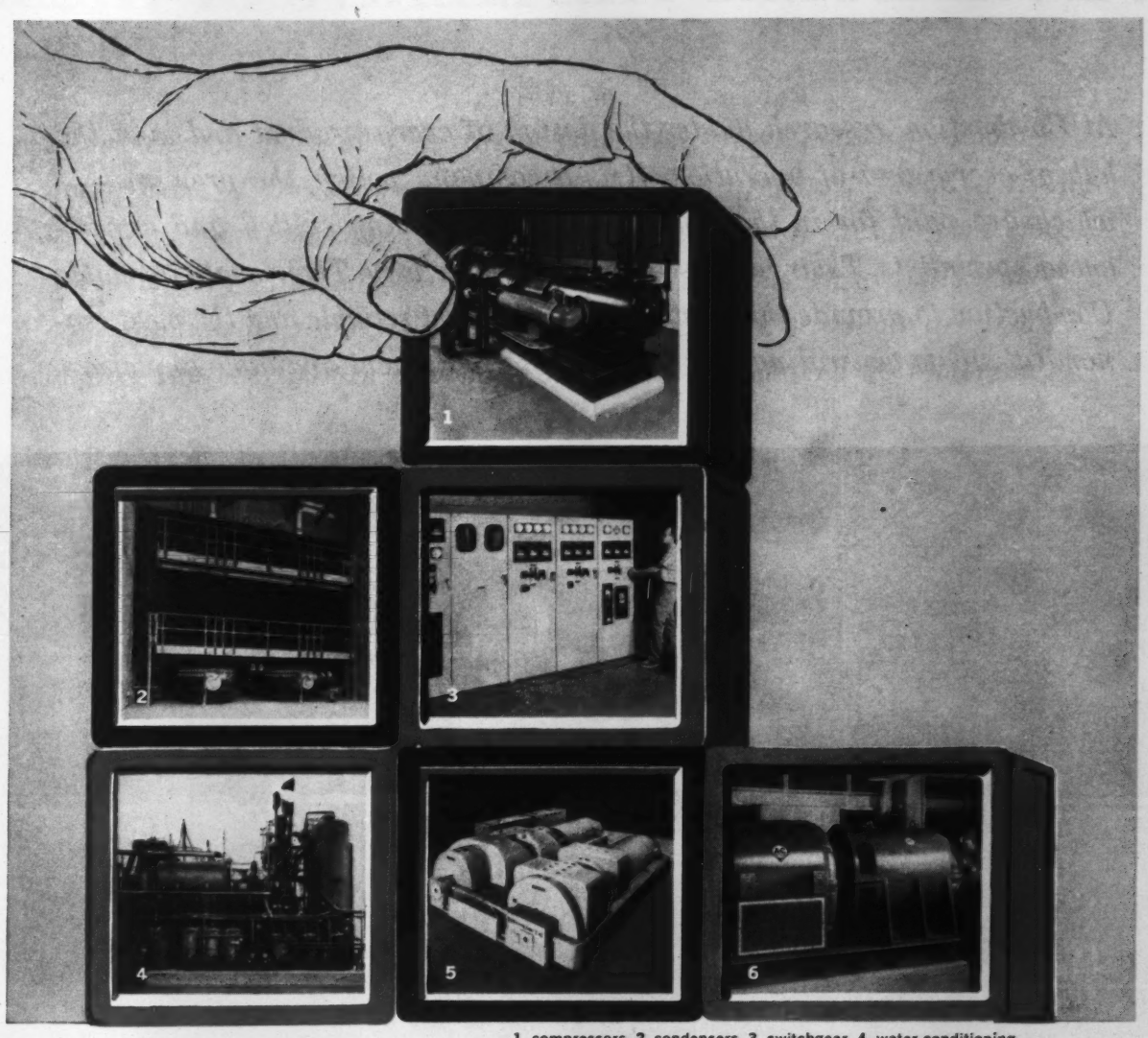
CLARAGE FAN COMPANY

Kalamazoo, Michigan

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

ALLIS-CHALMERS

A-1271



1. compressors, 2. condensers, 3. switchgear, 4. water conditioning, 5. steam turbines, 6. motor-generator sets.

Plan better, build better

with this single-source power equipment coordination

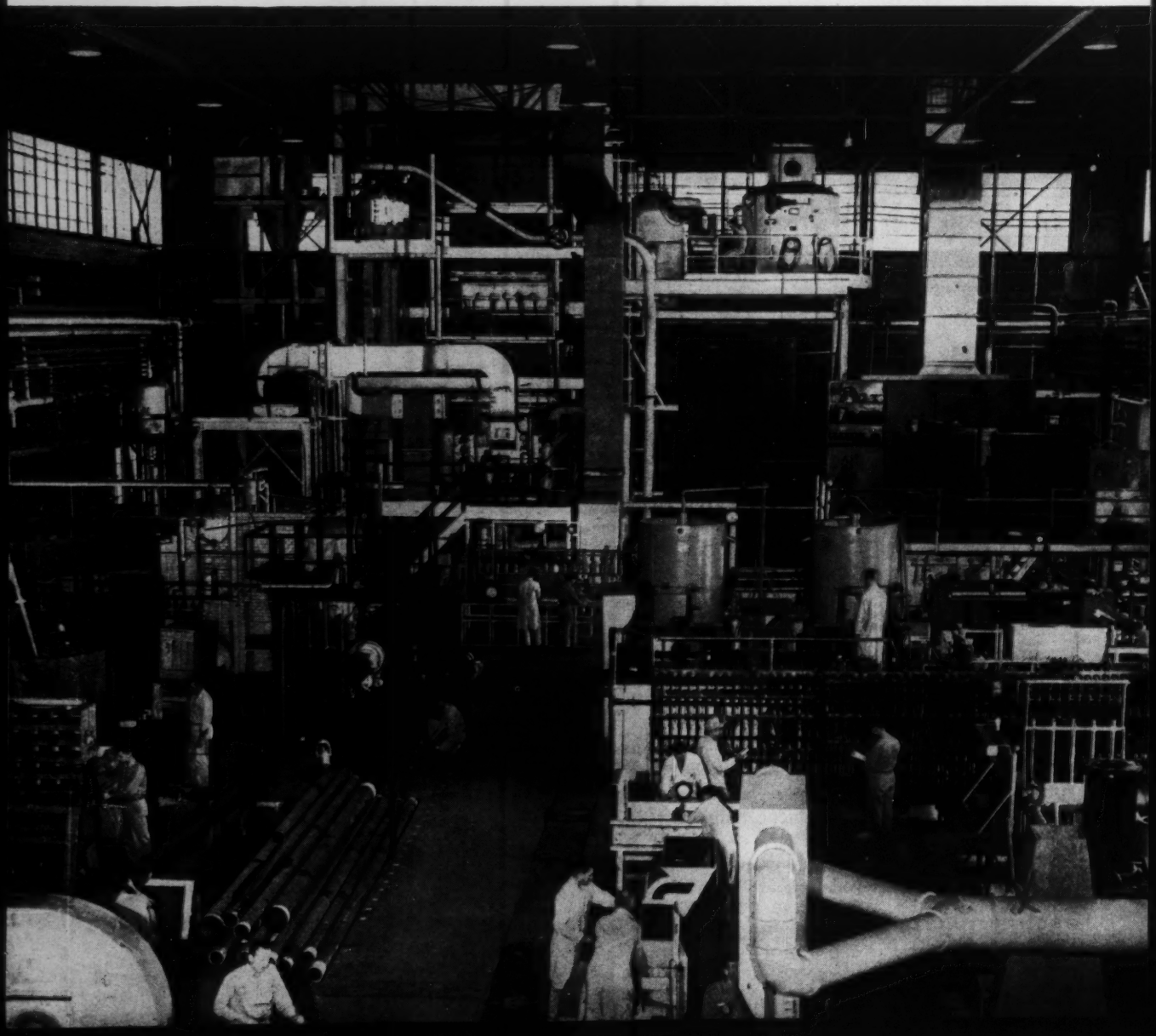
Allis-Chalmers range is wide — individual electrical products to complete power systems. And one A-C representative acts *in your interest*. He's the power product coordinator helping you plan and build better.

His obligations to you extend beyond products! He saves you time and money through single source buying. He coordinates engineering, products, delivery and service.

Briefly — he's Allis-Chalmers unit responsibility in *action. You'll find him at your nearby A-C office—backed in depth by Allis-Chalmers comprehensive Power Equipment Division.* ***Allis-Chalmers,*** *Milwaukee 1, Wisconsin.*

C-E MEASURES THE MERITS OF IDEAS

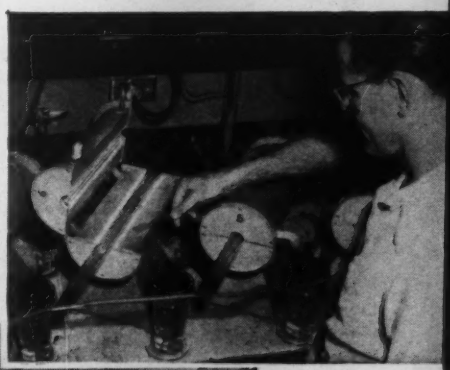
At Combustion, research guides the design of every product and is at the hub of every area of operation. It is a company policy, the premiums of which are paid for in the time and talents of many skilled and experienced specialists. Their purpose—to find a better way. Their goal—to enable Combustion to provide the most efficient, the most reliable and the most economical steam generating and fuel burning equipment available anywhere.



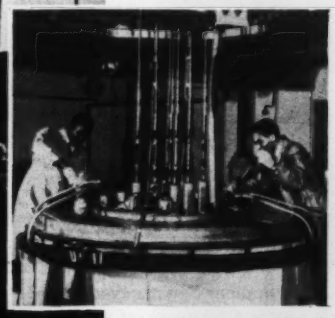
...WITH RESEARCH

Research activities at C-E range from studies of the nuclear characteristics of the atom and the combustion of fossil fuels to the development of methods and materials, the test of metals and the operation of test boilers and nuclear reactor systems. Research, knowledgeable and in depth, is your assurance that C-E products are thoroughly engineered, are dependable and are as modern as tomorrow.

THE KREISINGER DEVELOPMENT LABORATORY is used for the study of fuels and fuel burning systems, water, steam and combustion gases. It contains several test boilers, among them a large Controlled Circulation unit capable of operating at 2000 pounds pressure and a super-critical pressure boiler designed to produce steam at 5000 pounds pressure and 1200°F. This laboratory is one of eight C-E research facilities which, together, total more than four acres under roof.



THIS CHEMISTRY LABORATORY uses a battery of test furnaces to study the causes and effects of corrosive substances in combustion gases.



THIS ADVANCED CRITICAL FACILITY is one of two zero power nuclear reactors used by Combustion for test and experimentation.

THIS PHOTOELASTIC LABORATORY makes plastic models of various kinds of pressure vessels and loads them to simulate actual operating conditions. Using straining frames and polariscopes, it analyzes the stress patterns locked in the plastic to determine suitability of design.

THIS METALLURGY LABORATORY tests material strength at high temperatures with these creep-rupture machines.

THE COMPUTER CENTER is used for many kinds of research work. C-E utilizes both digital and analog computer systems.

COMBUSTION ENGINEERING

General Offices: Windsor, Conn. • New York Offices: 200 Madison Ave., New York 16 C-281A

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE.

IF YOU WANT TO TAKE A CHANCE ON FALLING IN LOVE WITH A COMPUTER

When we designed Recomp we had just two people in mind: the man who would use it and the man who would approve the investment.

We told our design engineers we wanted Recomp to 1] have a large capacity, 2] be versatile, and 3] be easy to program. Then we urged our cost engineers to see to it that Recomp stayed in the lower price range.

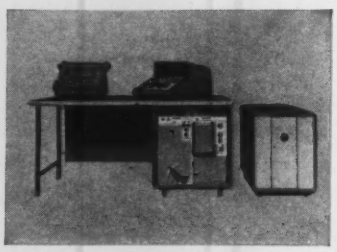
Quite honestly, this posed some problems. On occasion a designer would plead for his brainchild while the cost analyzers demurred.

No coins were tossed to settle such disagreements. If the designer could prove his idea made Recomp a better computer it was incorporated. That's how Recomp came to be the first solid-state digital computer on the market. And also why it was (and still is) the only compact computer with built-in floating-point arithmetic.

Fortunately when we were all through we found Recomp would sell at a sensible price. So, due to this strict attention to the computer's capability and cost, we're truly able to say **Recomp is the very best computer in the low-cost computer field.**

While they were at it, our engineers had some rather original ideas on how to present Recomp to you. "No gobbledygook," they said, "just give them the facts." So we painstakingly winnowed down a mass of superlatives to these plain facts:

1] Exclusive built-in floating point arithmetic.
2] Easy to program.
3] Efficient programming; 49 basic instructions expandable to 72.
4] Fast access time due to high-speed loops.
5] Magnetic disk memory with large capacity—up to 8192 instructions.
6] Large word length of 40 binary bits.
7] Each word contains two instructions.



8] Solid-state reliability.
9] Built-in square root command.
10] Large sub-routine and program library.
11] Active users group.
12] Built-in automatic conversion from decimal to binary.
13] Visual display of any word in memory.
14] Simple correction of errors.
15] Easily installed anywhere.
16] Can use conventional teletype equipment.
17] Low cost per computation.
18] High-speed input and output.
19] Programming training provided.
20] Large program exchange.
21] Coast-to-coast sales & service.

With all respect to our engineers, facts are fine but they can hardly do full justice to Recomp. For example, it's only fair to mention Recomp's appearance. Its soft color and modern shape bespeaks quiet efficiency; blends in the finest of surroundings. In this case you *can* tell the book by the cover. Recomp is truly a masterpiece of design (both in function and form). It's built to look as good as it is; a genuine pleasure to have around.

By the way, many of the points we listed above can be claimed by some other compact computers—but Recomp is the *only one* that can claim them *all,* and as standard equipment. You're never hemmed in on a problem by a lack of equipment.

True, you can get a computer that does more than Recomp, but this should only be if the size of the job justifies a much larger investment (and Recomp *does* have features you won't find in computers costing three times as much). Naturally, you can always find a computer that costs less.

But if you want a low-cost compact computer that performs favorably with the giants in size and cost, you should make a date to see Recomp. However, it's only fair to warn you, unless you want to take a chance on falling in love with a computer, don't write AUTONETICS INDUSTRIAL PRODUCTS, Dept. 117, 3584 Wilshire Boulevard, Los Angeles 5, California. **The Autonetics Division of North American Aviation, Inc.**

This simple change in specifications starts savings all along the line

BOSTON Gear OPTIMOUNT helical-geared RATIOMOTORS offer a choice of 456 mounting combinations, available FROM STOCK — save you the extra cost and the wait for "specials." You design for highest efficiency, then a phone call to your local Distributor brings you the OPTIMOUNT you specify — ready to install. He can furnish any quantity, and supply them as needed. You avoid big inventory expense, save production time.

You can order OPTIMOUNT Ratiomotors horizontal or vertical base mounted — with a choice of many shaft positions in either base — for any floor, wall, or ceiling mounting position — with single or double reduction helical gearing — for ⅛ to 10 hp drives. You get any arrangement specified, ready to install.

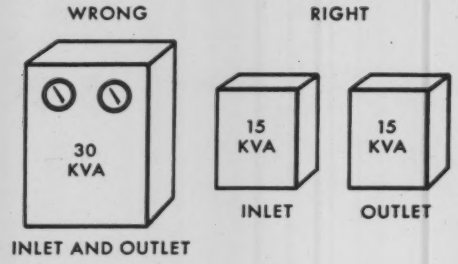
Call your Distributor today for complete information. Boston Gear Works, 66 Hayward Street, Quincy 71, Massachusetts.

Ask Distributor for NEW PRODUCTS SUPPLEMENT to Catalog No. 57

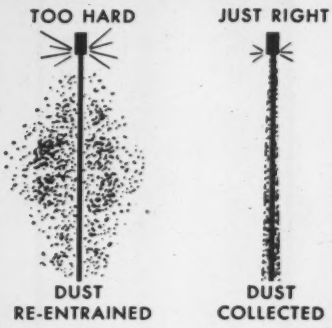
CALL YOUR NEARBY **BOSTON Gear® DISTRIBUTOR**

— *STANDARDIZATION PAYS* —

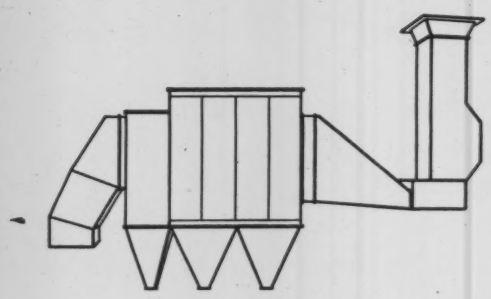
How to Evaluate Cottrell Precipitators



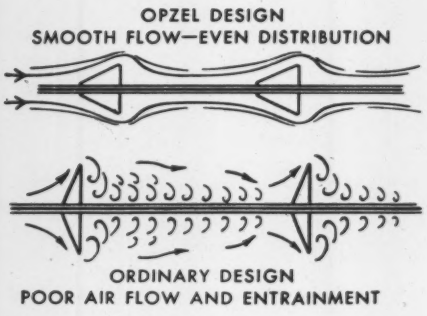
1. Electrical Sets should be arranged and rated to suit best the requirements of a specific job. Since electrical conditions can vary widely at different parts of the precipitator, it is good design to include several electrical sections in series, energized from separate sets so that each section may be energized as needed. Sets should be sized according to the amount of power the precipitator can absorb. A large excess of installed power, which will never be absorbed, means inefficient use of its equipment.



3. Rapping Intensity. Rappers should have easy means to vary the intensity of the blow to suit variations in operating conditions. A pre-set intensity setting cannot possibly give proper rapping over the normal range of operation. If too soft, build-up will occur which will disturb electrical conditions. If too hard, there will be reentrainment. Means of intensity adjustment are necessary to avoid drop-off of precipitator efficiency as conditions change.



2. Gas Distribution. Remember that gas distribution, gas baffling, and provision against hopper sweeping all have a large influence on collection efficiency. The gas flow system should be analyzed as closely as possible, both in the precipitator and in the associated duct-work. If in doubt, have a three-dimensional gas flow study made. Two-dimensional gas flow studies *are not as accurate* and may lead to erroneous conclusions.



4. Baffle Design. Careful attention to the design of baffles on the collecting plates is most important. Small amounts of reentrainment mean tremendous differences in over-all collection efficiencies. It is seen that the "quality" of the collecting surface is far more important than quantity—quantity (sq. ft. of surface or treatment time) in itself is not a criterion of performance.

The point of all this is that so many factors enter into evaluating an electrical precipitator that you should consult with the leading manufacturer—Research-Cottrell

Research-Cottrell, with over 1198 years of combined engineering skill and experience, is the undisputed leader in electrical precipitation.

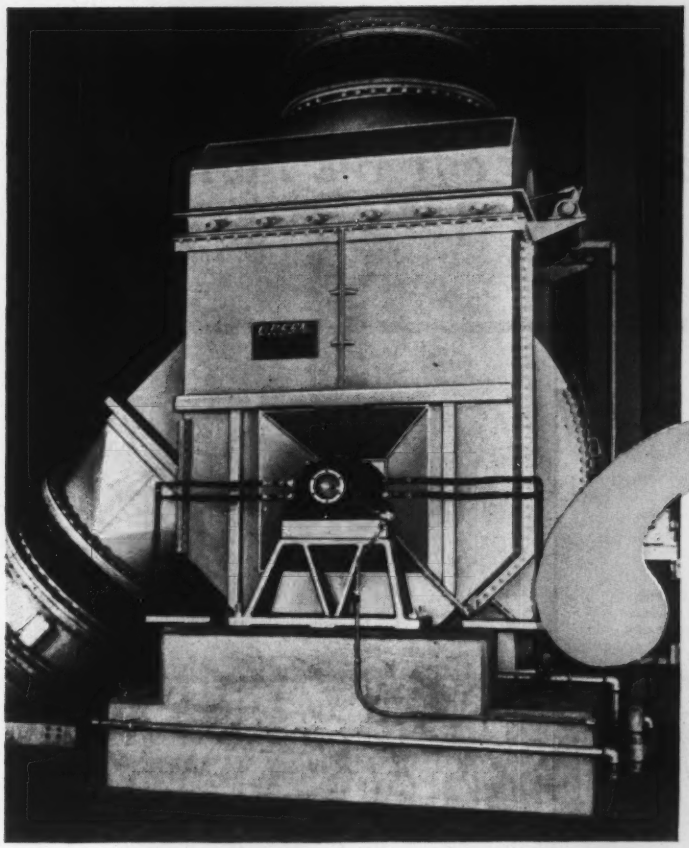
Research-Cottrell

RESEARCH-COTTRELL, INC., Main Office and Plant: Bound Brook, N. J.

Representatives in principal cities of U.S. and Canada

RC 204

TRADE MARK



One of Brookhaven's three Green induced draft fans. Each exhausts 109,000 CFM at 56" S.P. and 140° F., operating at 1775 RPM. Each rotor was successfully subjected to spin tests producing 50% greater than normal operating stress.

WHY DID BROOKHAVEN SWITCH TO GREEN HIGH PRESSURE FANS FOR ATOMIC PILE COOLING?

For 10 years, Brookhaven National Laboratory at Upton, N. Y. had used five fans of a leading make for exhausting the hot, slightly radioactive gases from its experimental atomic pile installation. These fans were still good, yet Brookhaven replaced them with three new Green units. Here's why:

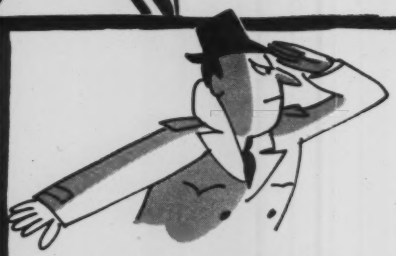
Due to design changes in the atomic fuel, the air flow requirements changed considerably thereby making it economical to purchase new fans. This change in air flow requirements plus the new Green fans with their forged and machined rotors and efficient airfoil design (smoother air flow, less turbulence, less shock or eddy loss) save a total of $15/hour in power consumption. Not only does the replacement installation pay for itself, it gives Brookhaven brand new equipment, the most modern of its kind, built to provide the reliability their atomic application absolutely demands.

It will pay you—as it did Brookhaven—to investigate the replacement of your present fan equipment with new high efficiency Green airfoil fans.

Green

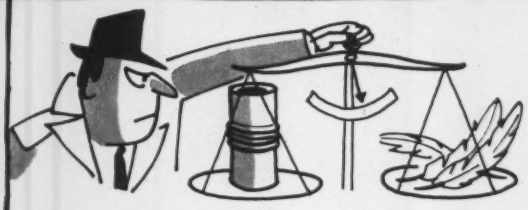
THE GREEN FUEL ECONOMIZER CO., INC. BEACON 3, NEW YORK

HOW TO SLEUTH OUT THE TRUTH ABOUT EXPANSION JOINTS



1 **Case the joint (design, that is)**

Badger S-R Expansion Joints have: 1. Corrugations which assume "all curve" shape under pressure — low stress, long life. 2. Tubular rings allow flexing over more of corrugation height.

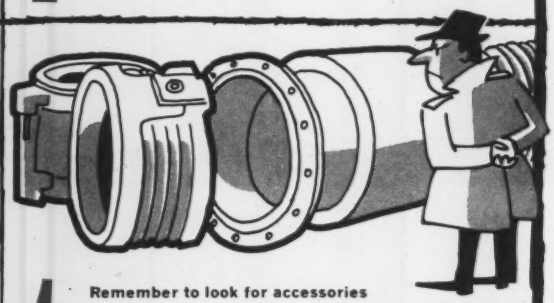


2 **"Weigh" the evidence**

S-R Joints have no bulky castings . . . weigh up to 50% less . . . diameter equivalent to pipe flange. Installation is easier, lighter supports required.

3 **Search for clues in fabrication methods**

Bellows are hydraulically formed to produce uniform corrugations with minimum thinning of material. Quality controlled longitudinal welding, no multiple circumferential welds.



4 **Remember to look for accessories**

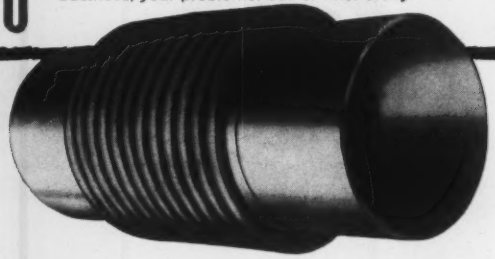
Full line of accessories — including covers and liners. Easy to pick proper combination of model, type and accessories for any pressure, temperature, erosive or corrosive condition.

5 **Pull an M.O. on the manufacturer's background**

Badger's 50-year experience includes development of first successful self-equalizing design for higher pressures, temperatures. Badger has had more fabrication and engineering experience in more different applications than any other manufacturer.

6 **Close the case — buzz Badger**

See the Badgerman for expert help on your most exacting pipe expansion problems. He knows his business, your problems. Call or write today.



BADGER *Expansion Joints* **S·R**

BADGER MANUFACTURING COMPANY
230 Bent Street, Cambridge 41, Mass.
Representatives in Principal Cities

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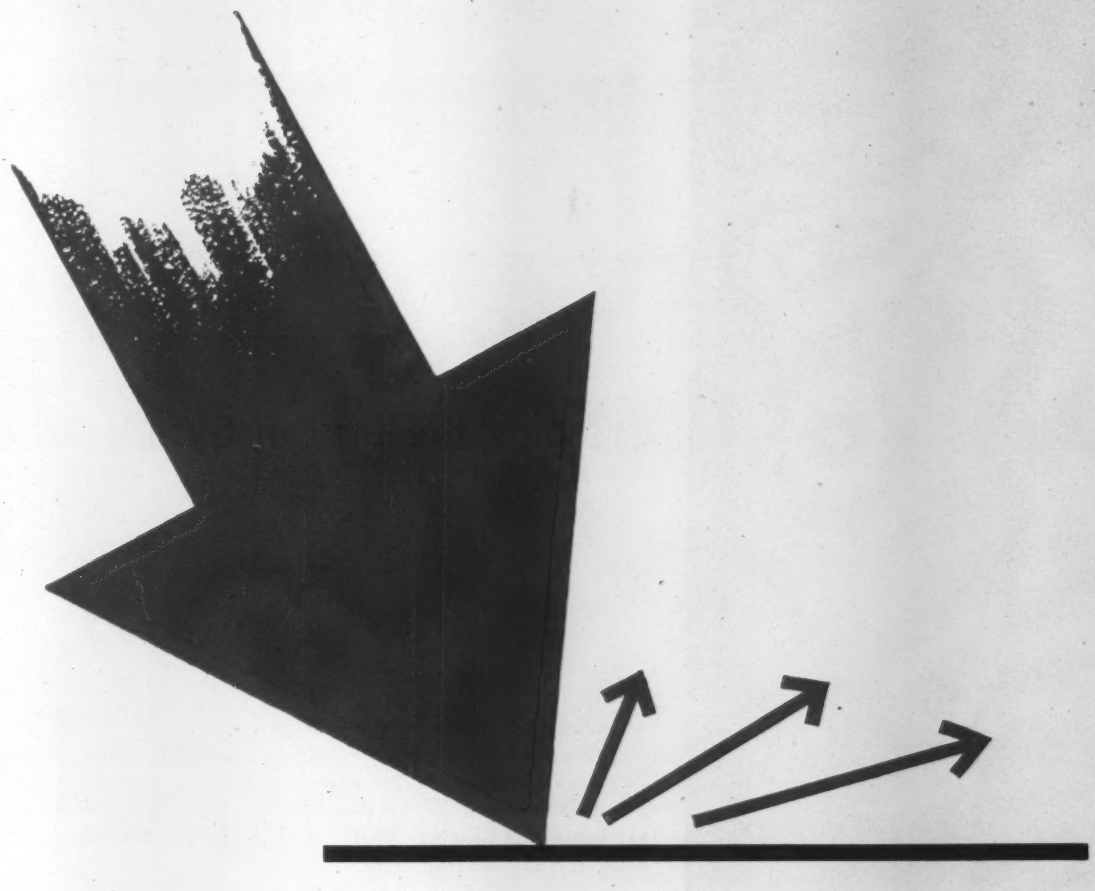


Metallurgical Phenomena... and the metals to cope with them.

These are the stock-in-trade of the Lukens Application Engineer—whether the problem be one of abrasive impact (symbolized above) or corrosion or pressure or structural stress or high and low temperature. Investigation of the best steels for "problem" applications has been carried on for years by the Lukens Application Research team. We would welcome the opportunity to contribute the results of this research to your own design knowledge. Please contact us in your early design stages. Call collect: Joe Proctor, Manager of Application Engineering, Extension 422, Lukens Steel Company, Coatesville, Pennsylvania.

HELPING INDUSTRY CHOOSE STEELS THAT FIT THE JOB

One of a series

Catching the Drift of Gyro Bearings

The fantastic accuracies needed by inertial guidance systems for space flight depend on the suppression of gyro drift, the tendency of a gyro to precess from minutely occurring internal torques. Particularly puzzling has been the problem of "jogs," or sudden axial shifts, within gyro spin-axis bearings. Shifts of but one ten-millionth of an inch can cause serious steering error.

Specialists at the GM Research Laboratories have found that the real key to drift lies in the thickness and distribution patterns of bearing lubricating films. Only a tenth of a milligram of oil — equivalent in volume to less than two-thousandths of a drop of water — is required in a gyro bearing, but even this amount unevenly distributed may cause jogs.

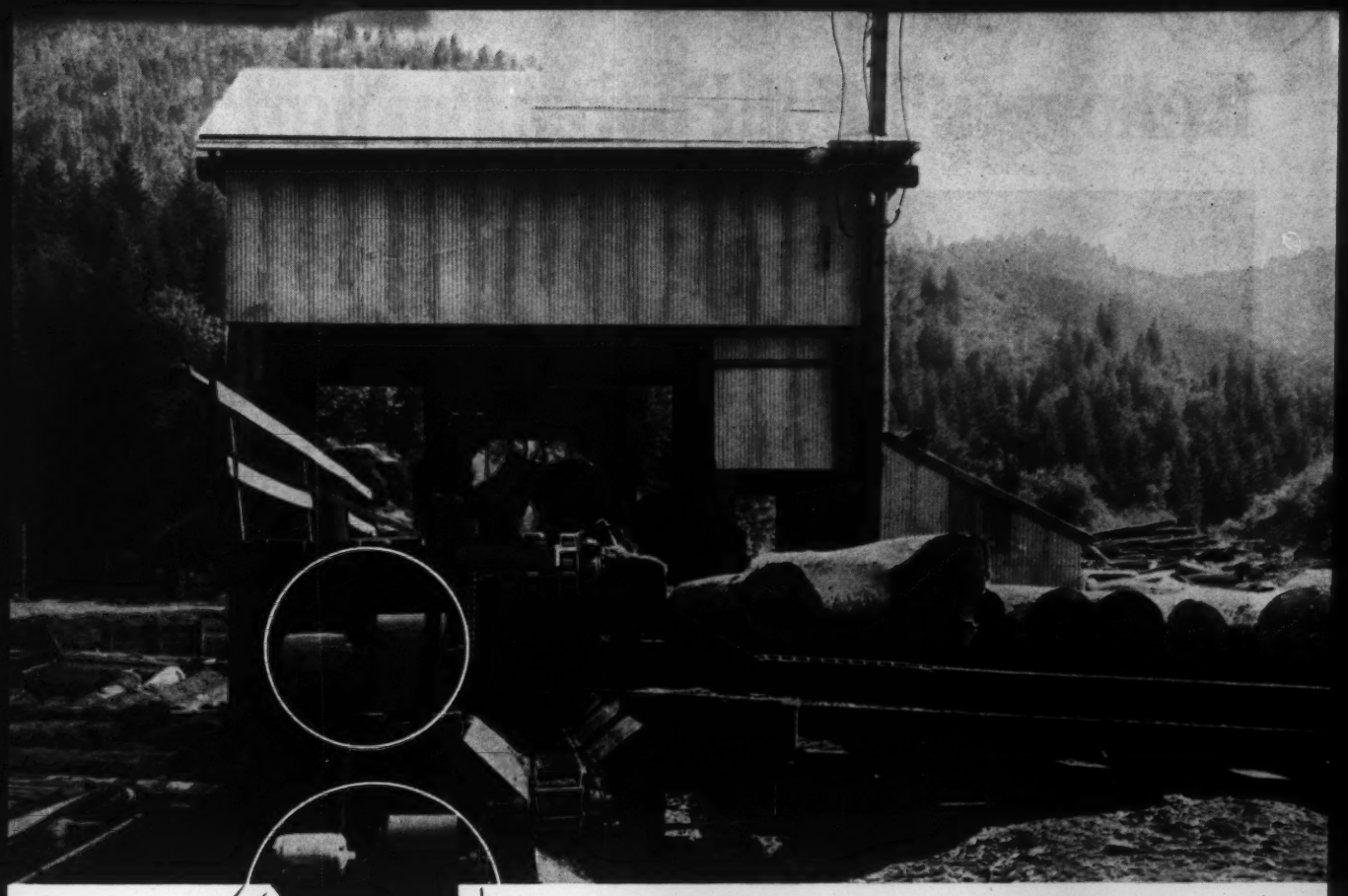
Conducting unique studies of single bearings apart from rotor assemblies, GM Researchers use a hydrostatic spindle and special instrumentation to take film-thickness measurements they compare with hydrodynamic theory. Jogs, due to excess oil supply, have been analyzed in relation to surface oil transfer and separator feed control, ball spin orientation, displacement, and differential heating and ball wander.

This experimental and analytical approach is achieving progress toward jog-free, stably distributed, and suitably thick oil films required in high-precision bearings. It is a further example of the critical and advanced research General Motors carries out in seeking "more and better things for more people."

General Motors Research Laboratories

Warren, Michigan

The fluoresced streaks show the disturbed "wake" of the lubricating film during bearing operation. The active part of the film, too thin to fluoresce visibly, averages ten-millionths of an inch in thickness.



FALK Motoreducers driving log conveyor and refuse conveyor at the modern mill of The Bohemia Lumber Company, Culp Creek, Oregon.

FALK *all-steel* Motoreducers give you longer service life

Whether your load conditions are normal or heavy, the extra rigidity of all-steel construction (more than twice that of cast iron) maintains better alignment of revolving elements under load...a vital factor in prolonging the service life of gears and bearings.

And if your installations are subject to shock loads, or accidental external impacts, you're way ahead when you install Falk All-Steel Motoreducers. These rugged units do not destroy themselves by tearing off their feet under jamming overloads, nor are their housings subject to cracks which both dissipate the vital lubricant supply and allow revolving elements to get out of alignment.

All-steel construction is one of the built-in extras that you get in Falk Motoreducers. Others include: (1) inherently stronger gear teeth (by AGMA standards), thanks to exclusive Falk extra-depth, high pressure angle helical gears; (2) maximum mechanical efficiency (98½% per gear mesh, under full load); (3) your choice of standard units (horizontal, vertical or right angle) to fit your precise requirements.

HORSEPOWER RANGE: to 75 hp . . . STANDARD OUTPUT SPEEDS: 780 rpm (high) to 1.2 rpm (low).

Prompt delivery from distributor stocks, or from warehouse or factory. Ask your Falk Representative or Authorized Falk Distributor for ***Bulletin 3100.***

THE FALK CORPORATION, MILWAUKEE 1, WIS.

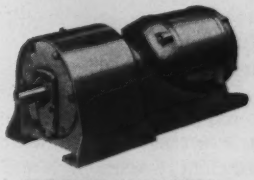
MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in most principal cities

FALK

. . . a good name in industry

Take your choice of all-steel drives when you specify Falk



THE FALK ALL-MOTOR MOTOREDUCER
...the original All-Motor unit

THE ALL-STEEL FALK SHAFT MOUNTED DRIVE

Torque ratings to 44,000 lb-in at low speed shaft. Also available in flange-mount design.

FALK and ALL-MOTOR are Registered Trademarks.

Kellogg's New Power Piping Plant

$4-Million Manufacturing Facilities Uniquely Equipped to Undertake Any Steam-Electric or Nuclear Assignment

Now in production at Williamsport, Pa., the Kellogg Power Piping Division's new plant is the most modern ever designed specifically to manufacture power piping for electric generating stations.

With these new facilities, Kellogg is equipped to undertake any steam-electric or nuclear assignment with greater efficiency, economy, and speed than ever before in its 40-year history of power piping leadership.

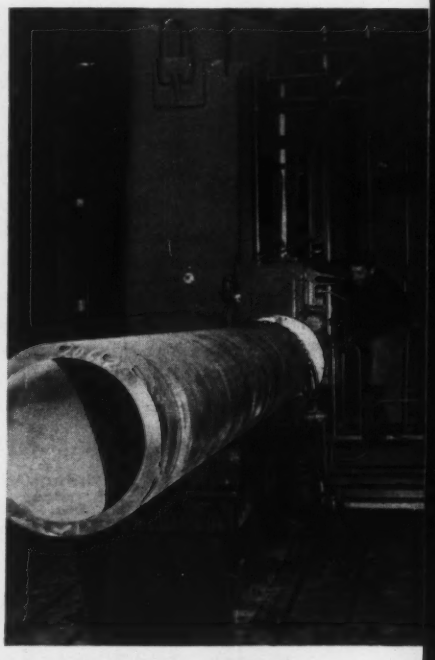
New equipment now in operation includes the latest machinery, worth in excess of $1 million, for machining, bending, and welding ferritic, austenitic, stainless, and other materials into piping of any wall thickness.

Carefully planned manufacturing sequences, on a production-line basis, assure a smooth and uninterrupted flow of operations from one end of the 900-ft. plant to the other.

Testing equipment for quality control includes the latest in electronic, radiographic, and ultrasonic advances. Two special vaults with 30-in. walls permit safe inspection with Iridium 192 and Cobalt 60.

Completely equipped metallurgical and welding laboratories, continually working to improve materials and techniques, aid in solving new manufacturing problems and are also available to clients as a service laboratory.

Kellogg's Power Piping Division welcomes inquiries on its new facilities, and extends a cordial invitation to engineers to inspect them personally.

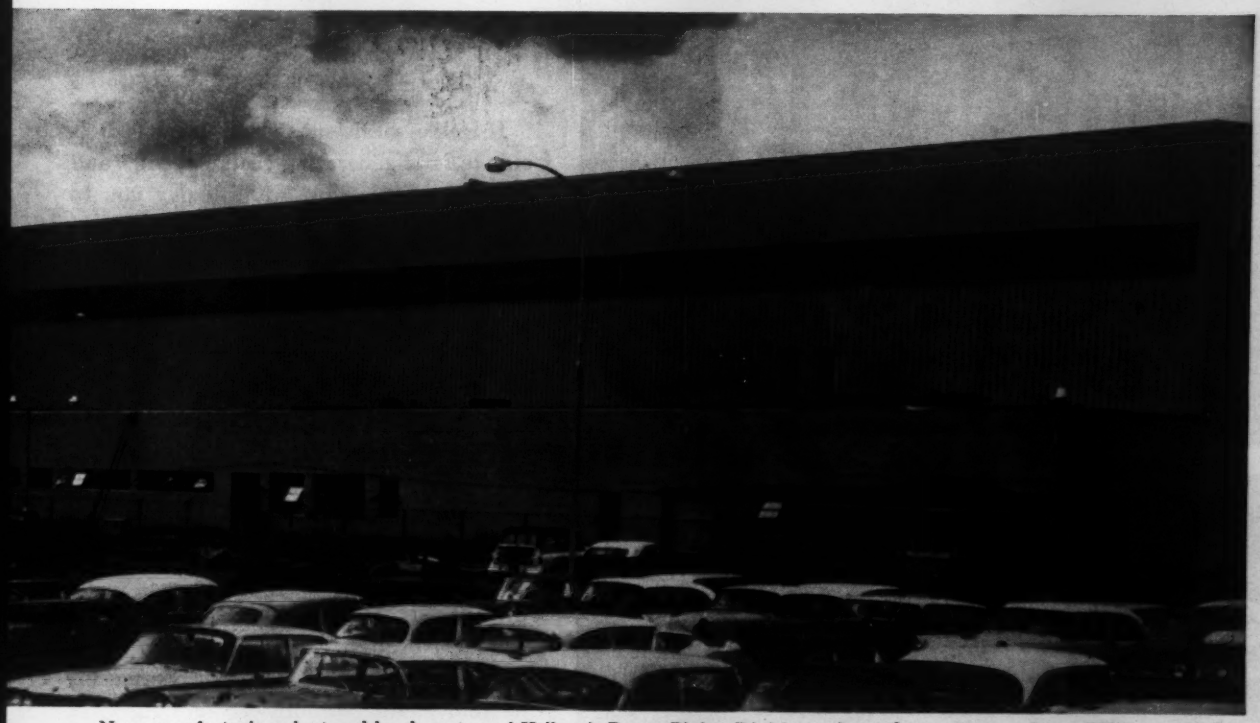


POWER PIPING DIVISION • THE M. W. KELLOGG COMPANY
Plant and Headquarters: Williamsport, Pa. Sales Offices: 711 Third Ave., New York, N.Y.
A SUBSIDIARY OF PULLMAN INCORPORATED

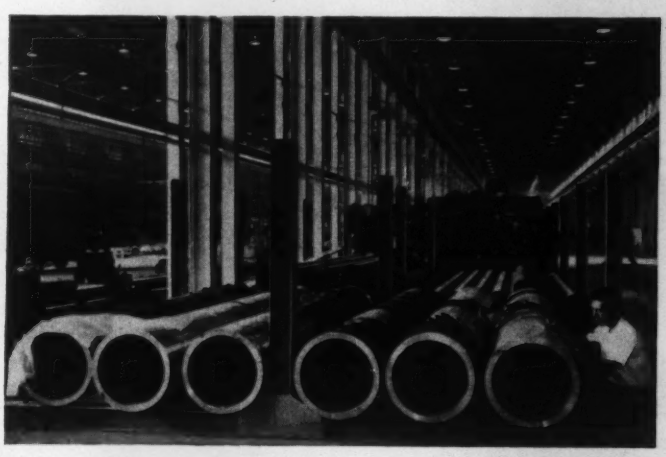
KELLOGG

Offices of other Kellogg companies are in Toronto, London, Paris, Rio de Janeiro, Caracas, Buenos Aires

Now In Production at Williamsport



New manufacturing plant and headquarters of Kellogg's Power Piping Division—situated on a 50-acre site at Williamsport, Pa.



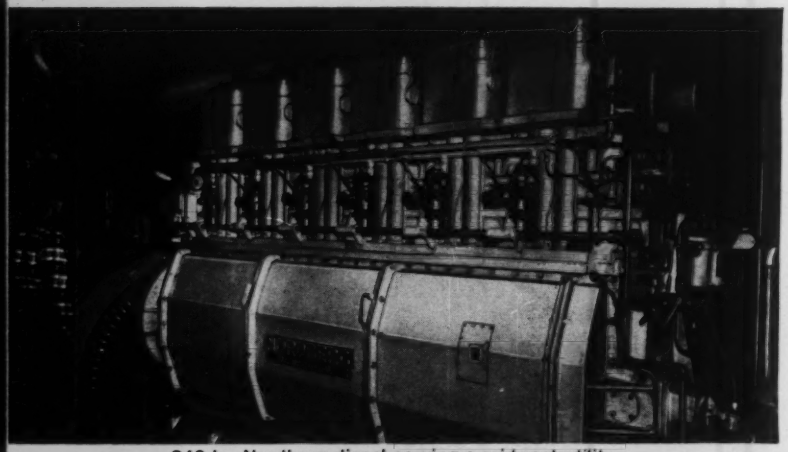
Above: Raw materials bay, 40-ft. wide, extends the entire 900-ft. length of the plant. Piping and fittings are conveniently drawn from storage by overhead cranes and placed in the production line at any point in a planned manufacturing sequence.

Left: One of the new boring mills at Williamsport. Piping in machine is a stainless steel section—to be installed by Kellogg field erection specialists in the reactor sphere of a nuclear power station.

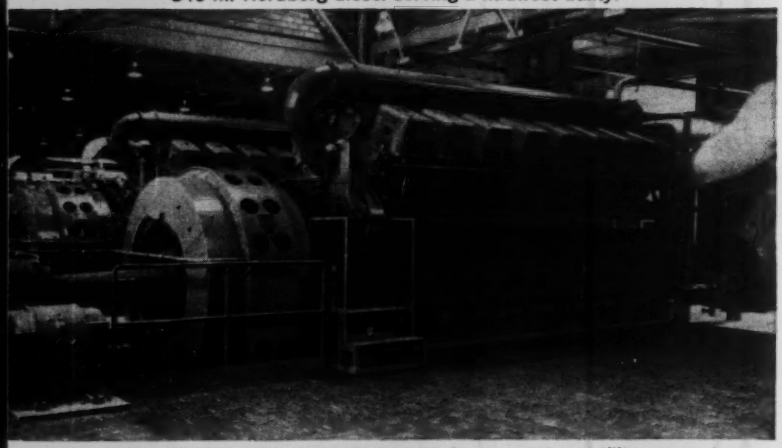
Above: Welding is a major phase of Kellogg's operations. Here, two thin-walled sections of stainless steel power piping are being joined by K-Weld—an inert gas-shielded technique of arc welding, patented by Kellogg, which assures long life.

Left: Front entrance of Kellogg's new Headquarters Building. This ultramodern office building houses administrative, engineering, estimating, and accounting departments of the Power Piping Division. Sales offices remain at 711 Third Avenue, New York, N.Y.

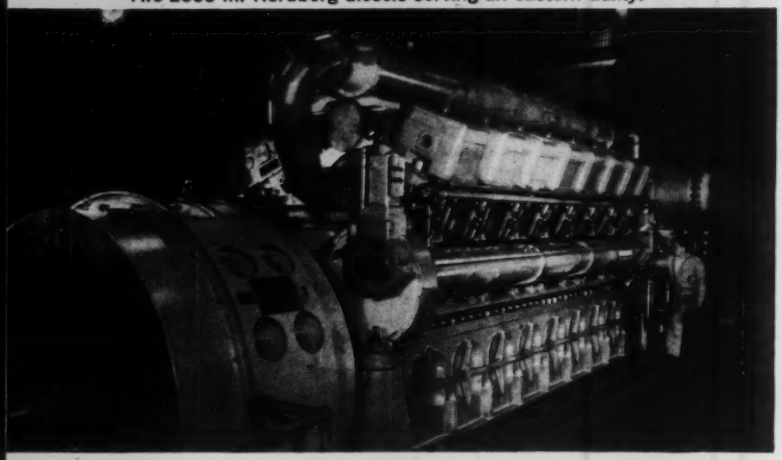
Cut power costs with NORDBERG ENGINES



840 kw Nordberg diesel serving a midwest utility.



Two 2500 kw Nordberg diesels serving an eastern utility.



2285 kw Nordberg diesel, one of three in a southern utility.

FOR STANDBY SERVICE

If lack of sufficient power makes it difficult to hold generating costs "down," and standby reserve "up," it will pay you to investigate the advantages of Nordberg engines. These efficient prime movers are easily installed independent of existing power facilities, go on the line quickly, and generate low cost power under all load conditions.

FOR PEAK LOAD SERVICE

If your base generating station is having difficulty "topping the load" at an economical figure, follow the example of many utilities who have assigned peaking problems to Nordberg engines . . . and in doing so have also added desirable generating flexibility and standby protection while amortizing their investment through more profitable operation.

FOR BOOSTING VOLTAGE

If your load has grown beyond the capacity of the existing transmission system and if there is difficulty maintaining voltage in outlying areas, Nordberg engines can give you the increased capacity at low cost per kwh. These efficient units are easily installed, and can be readily tied into the line at strategic locations to boost the voltage.

We will welcome your inquiry and the opportunity to discuss the advantages of Nordberg engines for your specific power requirements. Write for further details.

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P859

NORDBERG MANUFACTURING COMPANY • Milwaukee 1, Wisconsin

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CRITICAL PIPING FOR THE NUCLEAR AGE

A HOT TEST LOOP OF 10″ INCONEL

5945

PIPED BY MIDWEST

for Knolls Atomic Power Laboratory

Through this project . . . an important "first" in atomic power development . . . Midwest proved conclusively that heavywall Inconel piping can be fabricated and erected to meet the most stringent requirements.

Designed for testing materials and components of pressurized water reactors, this loop was fabricated by Midwest's St. Louis plant from Midwest-manufactured Inconel pipe and fittings, 10¾″ O. D. with a wall thickness of 1″. Other Inconel and stainless welding fittings and pipe, Inconel socket welding fittings and Inconel butterfly valves were also manufactured by Midwest.

Erection of the time- and money-saving prefabricated Inconel piping—all auxiliary piping, the complete electrical power and control system and instruments—was handled entirely by Midwest's competent field erection department.

For complete service . . . welding fittings, shop fabricated piping, and erection service . . . CONTACT MIDWEST.

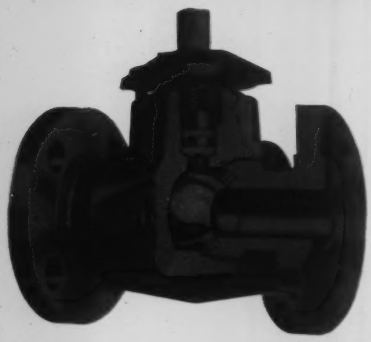
Write for NEW 20-page bulletin—CRITICAL PIPING FOR THE NUCLEAR AGE—describing Midwest's nuclear experience.

MIDWEST

MIDWEST PIPING COMPANY, INC.

1450 South Second Street, St. Louis, Mo.

LEAKPROOF AFTER 600,000 CYCLES!



Proved in the laboratory, and in over five years of field service with such difficult ladings as acetone, propane, vinyl chloride, and lime and soda-ash slurry, W-K-M's ACF Ball Valve has earned a reputation for extra long life *without lubrication*. For example —

In one test, W-K-M opened and closed a 2″ standard production model under pressure 600,000 times. The valve still sealed tight, and there was no measurable wear on either the chrome-plated ball or the Teflon seats!

W-K-M's rugged ACF Ball Valves are available in carbon steel to ASA 300 lbs. (some sizes 600 lbs.), and in semi-steel, ASA 200 and 400 lbs. WOG.

Write for Catalog 1000.

Conduit is full-bore; Teflon stem gaskets and seats are sealed from the lading flow.

WHEN SO MUCH DEPENDS ON A VALVE . . . SPECIFY ACF BALL VALVES

W-K-M

DIVISION OF ACF INDUSTRIES INCORPORATED
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6006

Utilizes Westinghouse silicon high-voltage rectifier cells

25% MORE EFFICIENT

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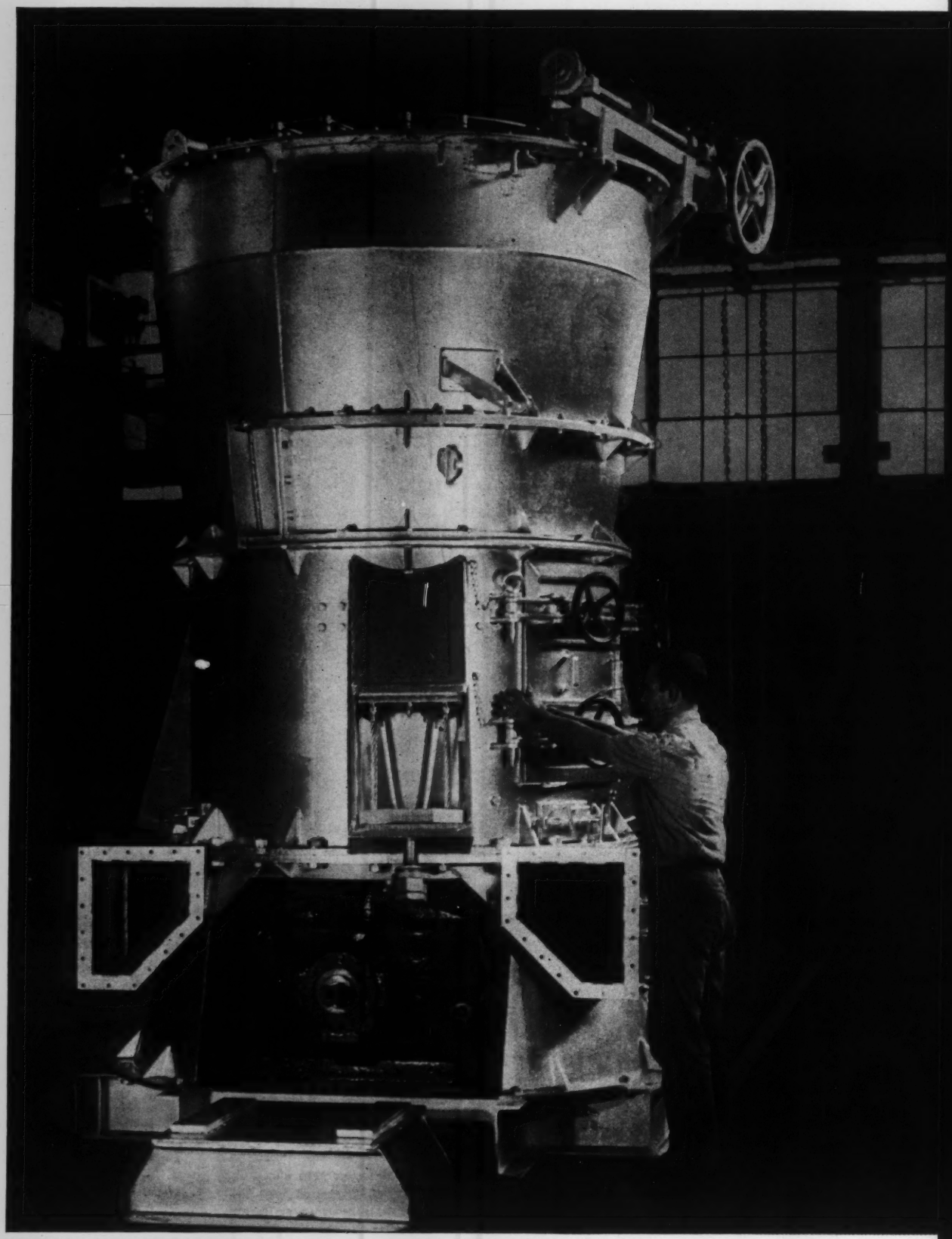
You get more power...reduce maintenance...increase reliability when you convert to Buell Silicon Rectifier Units

Buell Silicon Rectifier units can increase efficiency of your rectifiers 25% or more ■ Perfected and specifically designed for fast, simplified conversion of existing mechanical or tube rectifiers ■ They cut operating costs, reduce overall maintenance ■ Enable more efficient utilization of power ■ Eliminate rectifier maintenance ■ Reduce outages ■ Reclaim plant space ■ Suitable for indoor or outdoor installation ■ For only a small investment you can materially improve your rectifier performance ■ For details of the unit and a specific proposal write: Buell Engineering Co., Dept. 58-K, 123 William Street, New York 38 ■ Northern Blower Division, 6421 Barberton Ave., Cleveland, Ohio ■ CYCLONES, ELECTRIC PRECIPITATORS, BAG COLLECTORS, COMBINATION SYSTEMS, CLASSIFIERS, FANS.



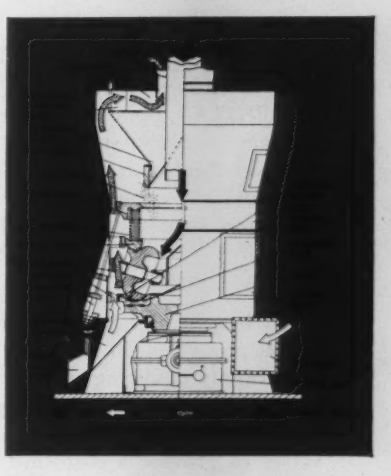
Foster Wheeler MB planetary roll and table pulverizer. Available with capacities from 2 ton/hr to 55 ton/hr.

Foster Wheeler MB Pulverizer, SIMPLE...VERSATILE...RELIABLE

The best combination of advantages for a wide range of fuel requirements

COMPARISON: Foster Wheeler MB pulverizer compared with two other leading pulverizers (A & B) available in U.S.

Power consumption	equal to A & B
Availability	better than A, equal to B
Accessibility	better than A & B
Floor Space	equal to A & B
Flexibility for suction or pressure operation	equal to A, better than B



European power companies have used the MB pulverizer for over 10 years. Low power consumption, low maintenance and the extremely high availability of the design are thoroughly proven.

Now further refined by FW engineers, and tested for two years in the U.S., the MB pulverizer deserves careful consideration in planning any fuel system which may require mill capacities from 2 to 55 tons of pulverized fuel per hour.

The MB design is extremely simple, providing reliability and ease of maintenance. The only moving parts inside the grinding area are three spheroidal rollers, a roller guide, and the powered horizontal grinding table. All adjustments can be made with the mill in operation.

The planetary motion of the rollers maintains uniform product fineness. Wear of grinding surfaces is extremely slow. The rollers and carrier need no lubrication. Noise and vibration levels are very low.

Provision is made for either pressurized or suction operation. In addition to coal pulverizing, the MB mill is also available for grinding gypsum, cement, solid chemicals, pigments, food products and other commercial materials.

Write for Bulletin MB-58-1, giving more detailed specifications for the MB mill. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.

FOSTER WHEELER

NEW YORK LONDON PARIS ST. CATHARINES, ONT.

GRAPHITAR®

(CARBON-GRAPHITE)

THE VERSATILE ENGINEERING MATERIAL THAT POSSESSES MANY UNIQUE AND PRACTICAL ADVANTAGES FOR A VARIETY OF APPLICATIONS

MINIMUM LUBRICATION REQUIRED —Because of the controlled porosity and non-melting nature of GRAPHITAR, the only lubricant GRAPHITAR bearings need is water or other low-viscosity fluid. Any such fluid with non-gumming characteristics will provide an extremely low coefficient of friction and assure long life of the GRAPHITAR parts.

RESISTANCE TO CHEMICAL ATTACK —GRAPHITAR has the ability to withstand the action of almost any chemical, with the exception of the most highly oxidizing re-agents in hot and concentrated form. GRAPHITAR parts, for example, operate efficiently in steam, chemical and gas valves to provide a corrosion resistant material operating under the most adverse conditions.

MECHANICALLY STRONG — GRAPHITAR will not warp or distort even in high pressure applications. Compressive strength up to 45,000 psi and transverse breaking strength from 3000 to 16,000 psi, depending on the grade.

HEAT RESISTANT—GRAPHITAR is not affected by heat under neutral or reducing conditions. Temperatures of oxidation for most grades is approximately 700 degrees F. In addition, GRAPHITAR engineers have developed a special oxidation resistant grade of GRAPHITAR that has been exposed in an oxidizing atmosphere (air) of 1200 degrees F. and after 200 hours, it showed a weight loss of less than six per cent.

MOLDABLE —GRAPHITAR has excellent moldability properties that make possible and practical unusual shaped parts. Design requirements such as ears, face slots, and outside diameter notches can easily be incorporated into GRAPHITAR parts without secondary machining and finishing operations.

MACHINING —The United States Graphite Company operates an excellent finishing department to do all finishing operations to the most exacting specifications. GRAPHITAR may be ground to size or shaped with a tungsten carbide or diamond tipped tool to tolerances as close as .0005". When surfaces require a high degree of precision in flatness, lapping and polishing equipment are employed and accuracies within three light bands can be produced.

LIGHT WEIGHT — GRAPHITAR is lighter than magnesium and is being employed increasingly in the aircraft and missile fields. The weight per unit volume of various GRAPHITAR grades is as follows: 102.8 to 116.03 pounds per cubic foot, .0595 to .0672 pounds per cubic inch, .952 to 1.074 ounces per cubic inch.

Write today for Engineering Bulletin No. 20

R-284-1

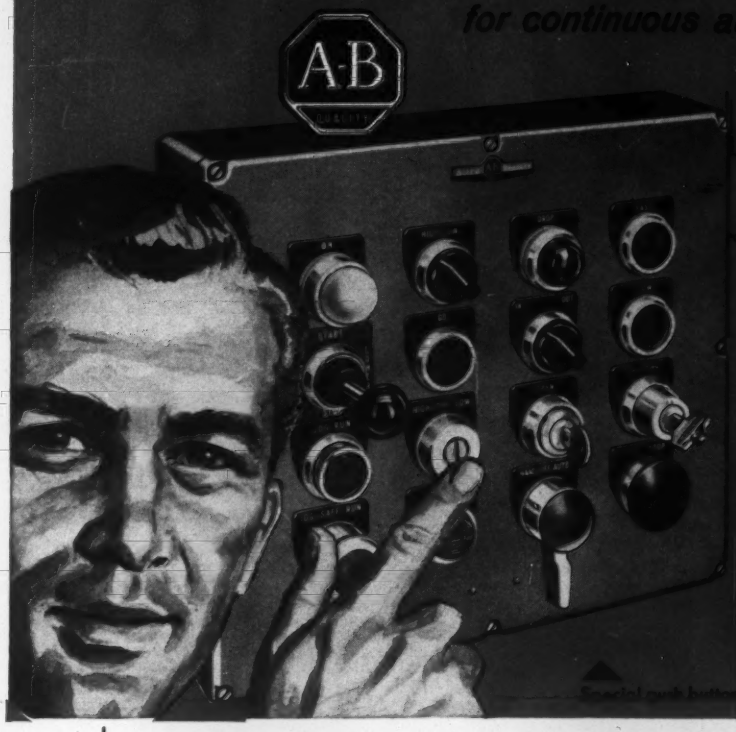
THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

AUTOMATION BEGINS HERE

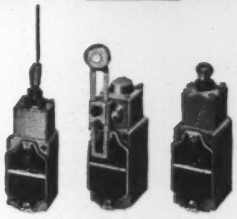
. . . Insist on Allen-Bradley accessories for continuous automatic production



In this broad line of Allen-Bradley accessories, each and every unit carries the traditional A-B trademark of *quality* that stands for trouble free operation. Rugged construction, and maintenance free, silver alloy contacts provide the reliability that is essential to the continuous operation of *your* automatic production machines.

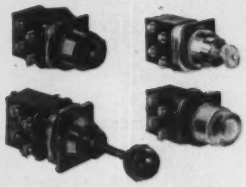
Profit from the experience of the leading machine tool builders . . . insist on Allen-Bradley *quality* motor control *all the way!*

Special push button panels can be assembled to your specifications.

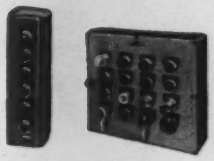


OILTIGHT LIMIT SWITCH
Bulletin 802T with sealed heads and bodies. Various operators.

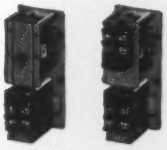
PRECISION LIMIT SWITCH
Bulletin 802 oiltight. Responds to very small operator travel.



OILTIGHT CONTROL UNITS
Bulletin 800T. Choice of push buttons, lights, and switches.



OILTIGHT CONTROL STATIONS
Bulletin 800T for up to 16 units in die cast aluminum enclosure.



PNEUMATIC TIMERS
Bulletin 849. Reliable and accurate. For on-delay or off-delay.

OILTIGHT PRESSURE CONTROL
Bulletin 836. For hydraulic systems with pressures to 5000 psi.

STANDARD DUTY PUSH BUTTONS
Bulletin 800. Up to three units, also pilot lights and switches.

FOOT SWITCH
Bulletin 805. In rugged die cast housing for toughest service.

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QUALITY MOTOR CONTROL

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FOR THE BENDIX G-15 COMPUTER

Speeds and Simplifies Problem Solving

ALGO extends the problem-solving horizon of every engineer, focusing the speed and precision of the Bendix G-15 computer on any algebraically stated problem. ● A true mathematical equation solver, ALGO permits any engineer or scientist to program the computer in universal mathematical language. No previous knowledge of computers or programming is needed. Input/output, computation and data handling are all automatically controlled by the G-15 computer. ● Compare the number of steps in the ALGO program illustrated below with the number required to solve the same problem on a slide rule, desk calculator or any other computing system. You will see the time and cost-saving significance of this new Bendix G-15 automatic programming aid. ● Specifically designed to take advantage of the computing power and flexibility of the proven G-15, ALGO is the newest addition to an extensive library of Bendix automatic programming systems. See how the low-cost Bendix G-15 and ALGO combine to broaden application boundaries. Learn how this powerful team can save you valuable time . . . and greatly simplify problem solving.

* AN ALGEBRAIC COMPILER BASED ON INTERNATIONAL ALGOL.

PROBLEM: $$I = \frac{E}{\sqrt{R^2 + (6.2832\,FL - 1/6.2832\,FC)^2}}$$

(For values of R F & L as specified. For values of E ranging from 100 to 300 in increments of 50. For values of C ranging from .00002 to .000021 in increments of .0000001)

COMPLETE ALGO PROGRAM:

```
BEGIN $
R = 10 $
F = 60 $
L = .2 $
FOR E = 100(50)300 BEGIN $
FOR C = .00002(.0000001).000021 BEGIN $
I = E/SQRT(R ↑ 2 + (6.2832 * F * L — (1/(6.2832 * F * C))) ↑ 2) $
PRINT (FL) = E $
PRINT (FL) = C $
PRINT (FL) = I $
```

Write on your letterhead for the self-teaching ALGO manual.

Bendix Computer Division
DEPT. AI-23 LOS ANGELES 45, CALIF.

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Performance makes the world of difference

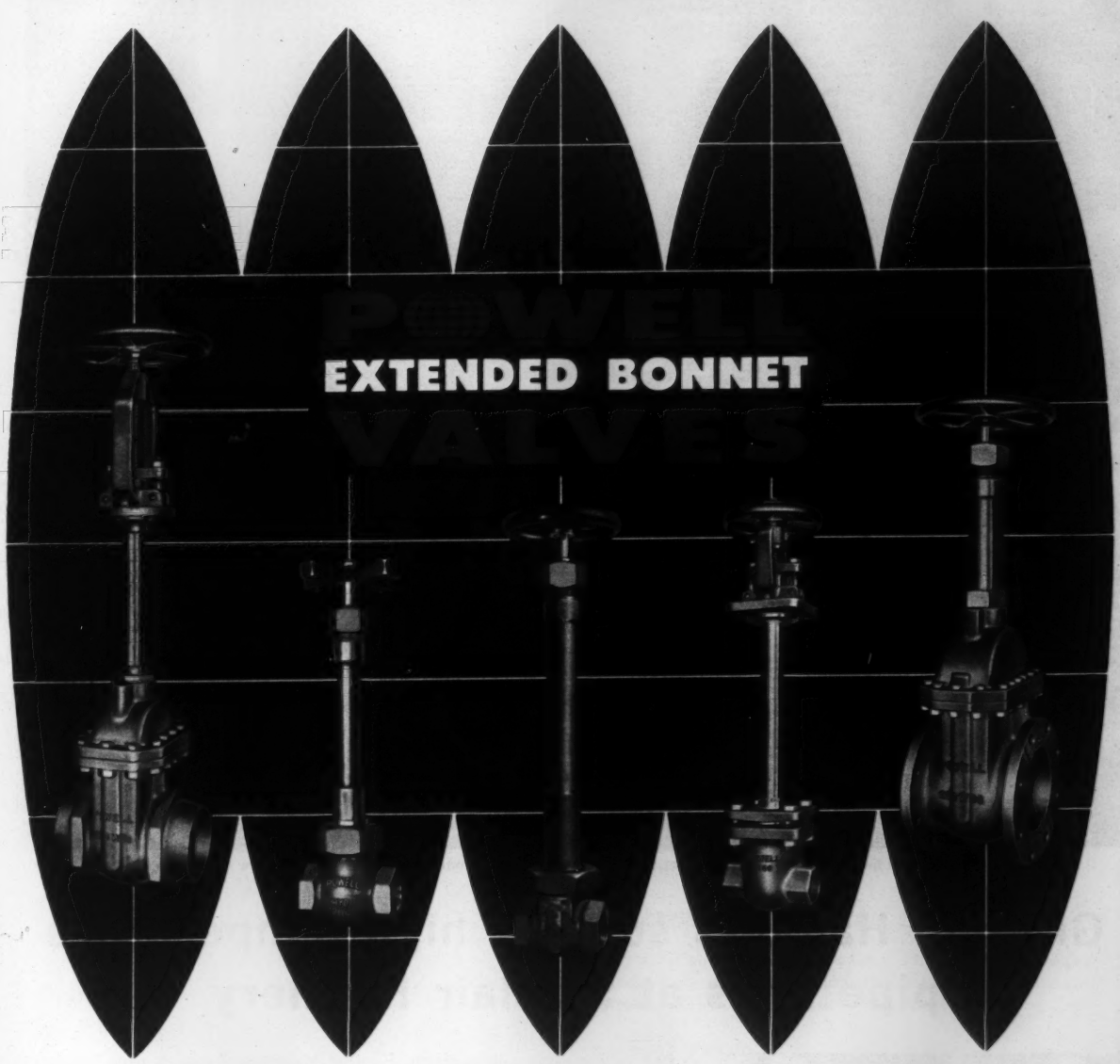


Fig. 70-1413—Bronze Gate Valve for 150 W.P., 200 W.O.G. Outside screw rising stem and yoke, extended bonnet, solid wedge disc, integral seats, socket ends.

Fig. 70-1175—Bronze Hydraulic Regrinding Globe Valve for 2000 W.O.G. Extended bonnet. Hard wear-resisting screwed-in seat ring and disc.

Fig. 70-375—Bronze Gate Valve for 200 W.P. 400 W.O.G. Inside screw rising stem, extended bonnet. Interchangeable solid or split wedge disc, integral seats.

Fig. 70-2490—Stainless Steel Gate Valve for 150 W.P., 400 W.O.G. Outside screw rising stem and yoke, extended bonnet, stainless steel solid wedge disc, integral seats, screwed ends.

Fig. 70-1401—Bronze Gate Valve for 150 W.P., 200 W.O.G. Inside screw non-rising stem, extended bonnet, solid wedge disc, integral seats, flanged ends.

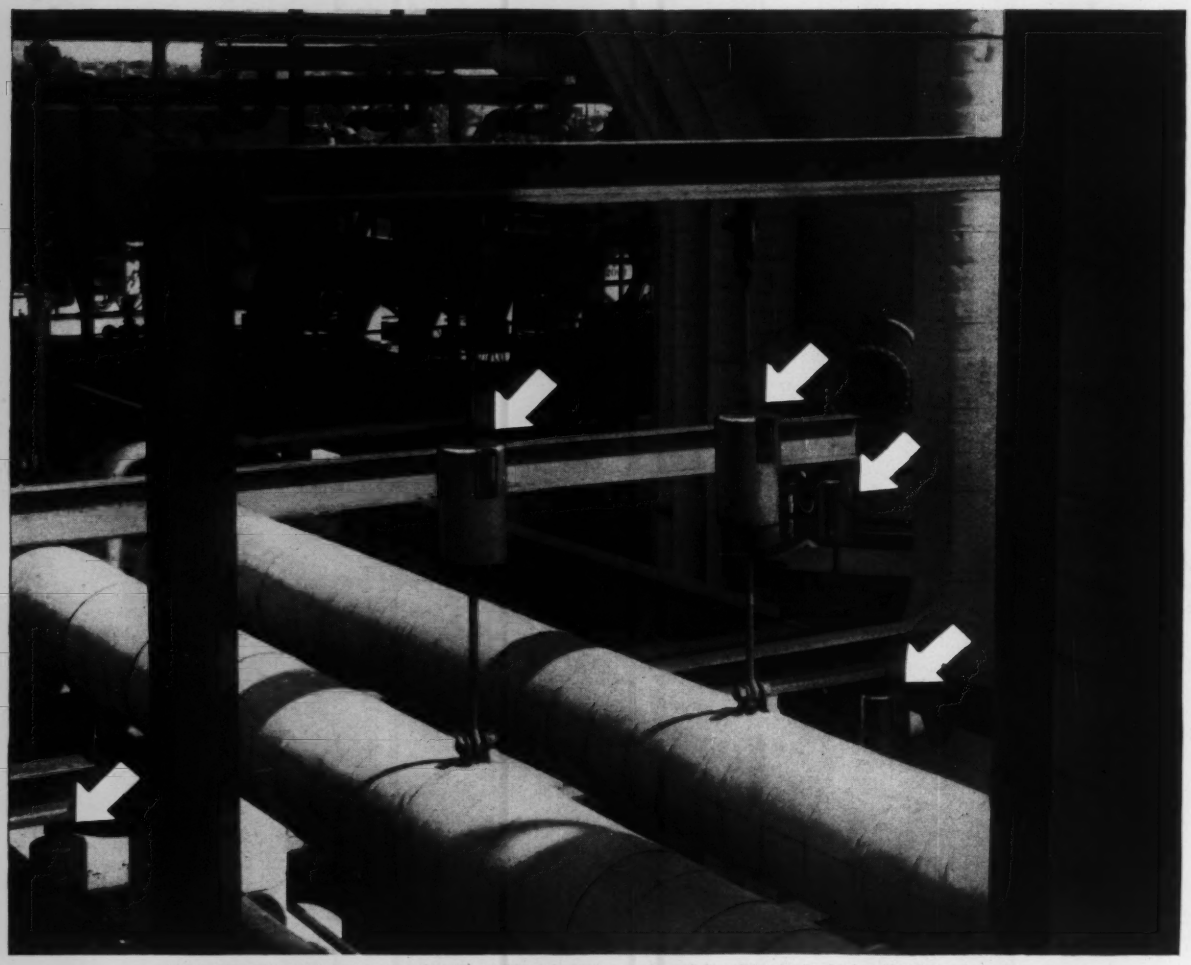
These Extended Bonnet Valves are especially designed to control the flow of liquids and gaseous fluids.

Here are a few of the many valves with EXTENDED BONNET made and recommended by Powell to handle liquid and gaseous fluids—oxygen, nitrogen, helium, hydrogen, etc. They are depended upon for long, uninterrupted, leak-tight service in defense installations to control the flow of the propellant fuels from storage into the missiles.

If you have an unusual flow control problem, or if you want complete information on the Powell Line of bronze, iron, steel and corrosion-resistant valves—our metallurgists, laboratory technicians and engineers are ready to serve you. Just contact your nearest Powell Valve distributor or write directly to us.

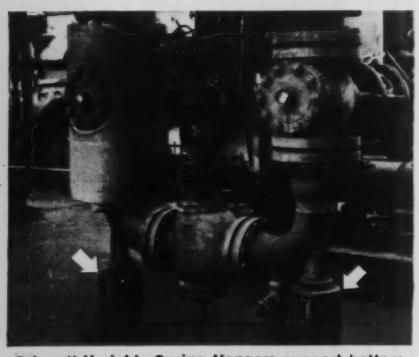
Powell . . . world's largest family of valves

THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO



Heater feed line (r.) and return line (l.) at Sinclair Refinery show Grinnell Variable Spring Hangers at work.

Grinnell Hangers support high-temperature pipe lines at Sinclair Refinery



Grinnell Variable Spring Hangers support bottom lines on vacuum still operating at 750°F.

Hot news: Grinnell variable Spring Hangers support pipe lines at Sinclair Refining Company's Marcus Hook, Pa. plant, that operate at temperatures *above 500°F.* Yet these flexible hangers easily accommodate thermal movement in the pipe lines!

Where reactive forces at terminal points must be kept within specified limits, *Grinnell Constant Support Hangers* are recommended. Where pipe lines are subject to vertical movement and restrictive conditions do not require the use of a constant support type, *Grinnell Variable Spring Hangers* are recommended. Where abnormal horizontal movement or vibration in pipe lines must be prevented, *Grinnell Sway Braces* are recommended.

Grinnell maintains a staff of trained technicians . . . provides highly skilled advice and assistance right from the design stage . . . offers experienced field engineering service. Call Grinnell Company, 277 West Exchange Street, Providence 1, R. I.

GRINNELL AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Pipe Fittings, Valves, Pipe Hangers, Prefabricated Piping, Unit Heaters and Piping Specialties • Branch Warehouses and Distributors from Coast to Coast

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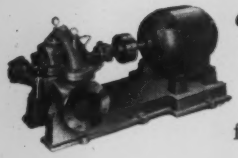
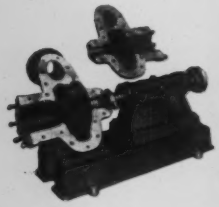
MULTIPLY ECONOMY by 5

When You Install Buffalo Pumps

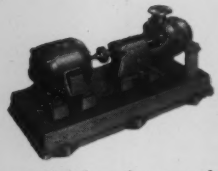
1. **Maximum parts interchangeability** reduces inventory costs.
2. **Emphasis on quality** insures extra years of economical, productive service.
3. **Peak hydraulic efficiency** insures lower operating costs.
4. **Sturdy, extra-heavy construction** means trouble-free performance.
5. **Complete Buffalo line** gives one-source buying.



Clear Water Pumps. For peak efficiency in clear water service. Highest quality construction assures long, maintenance-free life. Write for Bulletin 955.



Non-Clogging Pumps. Efficiently move high consistency liquids. The diagonally split shell gives easy access for inspection. Rubber-lined models for moving abrasive or corrosive liquids. Send for Bulletin 953.



Heat Transfer Pumps. Specially designed to handle high temperature liquids. Construction includes required alloys, water-cooled bearings and packings suited to the job. High-efficiency single suction, solid shell design. Write for full information.

Chemical Liquid Pumps. These specially designed pumps stand up under the severest service, handle most types of corrosive or abrasive liquids. Choose from numerous models in exactly the trim you need. Send for Bulletin 976.

High Pressure Pumps. Designed for boiler feed and other clear water installations. These rugged pumps assure peak efficiency, minimum downtime and long life. Operate against heads to 1500 ft. Capacities to 900 gpm. For complete details request Bulletin 980.

Close-Coupled Pumps. Save space without sacrificing efficiency. Installation is simplified, no need for shaft alignment. Vertical or horizontal installation. Discharge adjustable to desired angle. Send for Bulletin 975.

Helping you select the pumps that will serve you best and most economically is your Buffalo Representative's job. Contact him today, or write us for complete facts.

"Buffalo" PUMPS

BUFFALO PUMPS DIVISION

BUFFALO FORGE COMPANY

Buffalo, New York

Canada Pumps Ltd., Kitchener, Ontario

'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

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MECHANICAL ENGINEERING

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The Meeting and The Show

Late this month, "The Meeting" (the 1960 ASME Winter Annual Meeting) and "The Show" (the 24th National Exposition of Power and Mechanical Engineering) once again will focus attention on mechanical engineers: The subjects they discuss and the hardware that evolves as a result of their work.

This dual event, which will run from November 28 to December 2, 1960, is a must for every mechanical engineer. For example, at the meeting, besides the usual down-to-earth technical sessions in machine design, heat transfer, hydraulics, lubrication, maintenance, materials handling, production engineering, instrumentation, and the like, engineers in the aviation industry can, among other things, hear discussions on rocket power plants and an evaluation of heavy presses and their impact on the space age. Magnetohydrodynamic generation of electricity, the glamour electric generating process, will be covered in a fuels session. Management sessions will be devoted to the "Golden Jubilee of Scientific Management—Ten Years' Progress, 1950–1960." For the engineer who is confronted with the problem of designing for nuclear blasts, a colloquium on shock and structural response has been scheduled by the Applied Mechanics Division.

In all, nearly 350 papers will be presented at 122 technical sessions.

At the show, visitors will see a galaxy of displays ranging from new mechanical equipment and manufacturing supplies to a model of the world's largest atomic power plant. There will be live demonstrations of new welding and other techniques plus working models of mechanical equipment. New aids to the economy of electric generating stations—automatic control—mechanical tabulation of live statistics will be on view. Complete equipment specialties for entire plants will be shown by several exhibitors: Instruments; a performance monitor that indicates the trend in operating economy; an annunciator system that indicates any abnormal condition anywhere in the plant. Improved methods of fabricating metals for centrifugal castings and extruded parts up to 8 in. in diam will be exhibited. Also to be shown: Centrifugally cast heavy-walled pressure piping for nuclear service and high-pressure high-temperature alloy and carbon steel pipe, specially fabricated for electric generating stations.

More on the show can be found in the special insert, pages 141 to 148, which includes exhibit floor plans, a list of exhibitors, and ASME Meeting and Show high lights.

And, on pages 57 to 79, a special editorial feature section brings together a series of papers on Thermal Efficiency, System Expansion, Power Plant Automation, and Power Reactors. The Theme: Power Plants—Tomorrow.

Both "The Meeting" and "The Show" will provide engineers with needed information in all branches of mechanical engineering, from project planning and mechanical design to plant supervision and operation. The dates: November 28 to December 2, in New York City. The Statler Hilton Hotel will be headquarters for the ASME Winter Annual Meeting while the Power Show will hold forth at the New York Coliseum.

Don't miss these two events. It will pay you to attend.

J. J. Jaklitsch, Jr.

Editor, J. J.JAKLITSCH, JR.

The point of greatest return is the relationship between the supervisor and the supervised. The things that motivate men are not as elementary as they once were.

The VITAL SPOT in

By D. Robert Yarnall, Jr., Assoc. Mem. ASME,

In this country, 100 years ago, only 1 person out of 5 worked for somebody else. The other 4 out of 5 were predominantly independent farmers, shopkeepers, professionals, and craftsmen. Now, the ratio has been reversed—4 out of 5 work for somebody else—and the supervisor-subordinate relationship is a basic aspect of human experience in our highly organized, industrial society. The nature of this relationship is of profound importance to the individuals involved and to the results they achieve in their work.

Lawrence Appley, president of the American Management Association, has written: "The most vital spot in management is the point of contact between worker and boss. The focal point, the point of greatest return, is the relationship that exists from day to day between the supervisor and the supervised on all organizational levels. Making this relationship constructive and productive merits more attention than any other management activity." It may seem obvious that "the point of greatest return"—in terms of results and effectiveness—is the relationship between the supervisor and the supervised.

But let us explore why it is true.

The boss is accountable to his boss for results. He must achieve these results through the work of other people, the people whom he supervises. Whether the results (and hence the boss's performance) are good, bad, or indifferent will depend on whether the work of his subordinates is good, bad, or indifferent. And, in the author's experience at least, the greatest single factor determining whether the subordinates' work is good, bad, or indifferent is the quality of the relationship which exists between them and the boss.

This certainly does not mean that all the boss has to do is keep everbody happy and satisfy their every whim. Harmony and contentment, of themselves, do not and cannot insure productivity. Nor is there some convenient "human-relations gimmick" which will serve as a successful substitute for job competence, operating know-how, and sound strategic decisions on the part of both the boss and his subordinates.

Plan, Organize, Motivate, Measure Results

There are no short cuts. In setting out to achieve the results for which he is accountable, the boss must do four things, all of which are important. He must plan. He must organize. He must motivate; and he must measure results. Look at each of these functions in a little more detail!

First of all, he must develop a plan, starting with a clear understanding of the objectives and the means of getting there. This will include such things as basic strategy, a timetable, and an estimate of the people, money, materials, equipment, and other resources.

He then must organize a group of people capable of reaching the objective. This requires careful analysis to develop a clear statement of the basic qualifications—physical, mental, and special training—which the people must have to start with. Then people must be recruited who possess these qualifications. It should be emphasized again that there is no "human-relations" substitute for having people who possess the basic job competence which is required—the "can do."

Once the basic plan has been developed and people who have the necessary qualifications have been selected, the next step is to see to it that they are motivated to reach the objectives—that is, provided with the necessary

Contributed by the Management Division and presented at the Summer Annual Meeting, Dallas, Texas, June 5–9, 1960, of The American Society of Mechanical Engineers. Condensed from Paper No. 60—SA-30, originally entitled "Motivating Subordinates to High Performance."

Management

Vice-President, Manufacturing, Yarnall-Waring Company, Philadelphia, Pa.

"will do." "Motivate" is defined as "to impel, to incite into action," and that is exactly what must be done.

The final requirement is the measurement of results. It is obviously important to the boss, to his boss, and to his subordinates that this part of the job be well done. It may take the form of balance sheets and profit-and-loss statements, or performance against a budget or sales quota, or it may involve physical tests, or some sort of sampling, or perhaps the results of a questionnaire of some kind. The important thing is that the factors selected should be relevant to the results desired, that they are actually subject to reliable measurement by the means available, and that they are understood by the people whose work is being measured.

Planning, organizing, motivating, and measuring re-results—each is essential, and each comprises a deep and fascinating aspect of management about which volumes have been written. Without minimizing the importance of the other three, however, it is the boss's success in motivating—in stimulating the "will do" in his people—that will produce the greatest rewards in results over and above that which just "gets by." And this margin is often the make-or-break margin, the succeed-or-fail margin in our highly competitive world. The more advanced our technology, the wider and more important the range between potential performance and merely passable results becomes.

How Are We Motivated?

If motivation is so important, how then is human effort to be motivated toward realizing the highest objectives of the organization? To answer this, it will be necessary to seek the help of the psychologists who explain man's behavior, at work and elsewhere, as the result of his effort to satisfy certain basic needs. As soon as one of these needs is satisfied it is no longer a motivator of behavior and another appears in its place. These needs are also arranged in a hierarchy of importance.

At the bottom of the list are the physiological needs for such things as food, shelter, clothing, rest, and exercise. These needs are pre-eminent when they are unsatisfied. Man *does* live by bread alone when there is no bread!

At the next level are the safety needs for protection against danger and deprivation. Fear is a powerful motivator of behavior when this need is unsatisfied.

When man's physiological needs and safety needs are reasonably satisfied, his social needs become significant motivators of his behavior. These are his needs for belonging, for acceptance by his fellows, for giving and receiving love and friendship.

Above these social needs are the so-called ego needs which include the needs for status, for respect, for recognition, for self-esteem, and for independence. Unlike the lower needs, these are not often satisfied, and they do not become operative in any significant way until the physiological, safety, and social needs have been reasonably satisfied.

Highest in the hierarchy of man's needs is what might be called the need for self-fulfullment. This includes the need for realizing one's highest potential, for being creative in the broadest sense, for deepening religious, artistic, and intellectual insights, and for developing truly mature relationships with others.

In an earlier day the boss usually motivated his people with threats and/or promises of reward which were largely aimed at satisfying their physiological and safety needs. This worked so long as men struggled for subsistence and lived in constant fear of unemployment, but it is not nearly so effective in a happier society where most men have reached an adequate subsistence and safety level, and hence are motivated primarily by higher

The VITAL SPOT in Management

needs. Today's boss must therefore acquire real understanding of the social, ego, and self-fulfillment needs of his people if he is to understand what may motivate them to the highest levels of performance.

Where will such understanding lead in determining the attitudes and actions of the boss which will be most effective in getting high performance from his subordinates?

The Boss's Attitudes

Consider attitudes first. The boss who is most effective in getting really good results is likely to:

1 First of all, have faith in other people. He believes that most people are basically good, that they want to do the right thing, and that they are fundamentally trustworthy, until proved otherwise. He has come to recognize that people respond favorably to evidences of genuine trust in them.

2 Believe that people should be viewed as ends in themselves rather than as means. Instead of wielding power over other people, he prefers to use power in working with people. He inclines toward developing associative relationships with his people—associated together in a common undertaking rather than in an arm's-length, master-servant relationship.

3 Think of the growth and development of his subordinates in terms of providing them with opportunities and encouragement for self-development rather than trying to mold them in his own or some other preconceived image.

4 Understand and have deep respect for the rights of every person in the organization:[1] (*a*) To be treated as an individual and respected as a person; (*b*) to have a voice in his own affairs and to contribute to the best of his ability in the solution of common problems; (*c*) to have recognition for his contribution to the common good; (*d*) to develop and make use of his highest capabilities; (*e*) to receive fairness and justice in all his relationships with superiors.

Is this a naive view of the attitudes to be expected in an effective boss? Perhaps it is. Obviously, it is drawn from a view of the nature of man which is not shared by everyone. But, in the author's experience, managers who have had this kind of attitude toward people and their work have been the most effective managers in terms of achieving real results.

The Boss's Actions

Obviously, actions as well as attitudes are required. The boss who is most effective in getting best results through motivating his subordinates to high performance is likely to:

1 Think and talk and act in terms of "management by objective" rather than "management by direction and control." He is more interested in results—excellent results—than in controlling the precise methods used by his subordinates.

2 Invite his subordinates to participate in establishing their work objectives within the over-all objectives for which he is responsible. He has found that this practice improves the understanding and acceptance of the objectives and gives the subordinate a real stake in the outcome.

3 Understand clearly that this sharing of responsibility does not in any way relieve him of the ultimate accountability for over-all results. He sees to it that each of his subordinates understands clearly at all times the results for which he is accountable.

4 Try to provide each subordinate with the resources and authority (which might better be called freedom to act) which are required to get the results for which he is responsible.

5 Make clear the boundaries, pitfalls, and guiding policies within which subordinates must act.

6 Be sensitive to the uniqueness of individuals and the fact that each of his subordinates is a completely different person. He also tries to be sensitive to his own impact on his subordinates.

7 Demonstrate real confidence in his subordinates and make them realize that he wants them to succeed!

8 Be sincere, consistent, and absolutely honest in all his dealings.

9 Make a real effort to keep his subordinates fully informed—not only on matters related to their immediate responsibilities but also the general background information which will help them to understand their role as part of a larger undertaking.

10 Encourage teamwork and co-operation among his subordinates, making it clear that he expects them to work together to resolve their differences and solve common problems.

11 Realize that new ideas are fragile! He is careful never to ridicule any idea advanced by a subordinate, having learned that the best ones are not necessarily the first ones.

12 Tend to take a problem-solving approach directed toward remedial action when difficulties arise.

13 Not freeze subordinates with fear of making a mistake, or fear of admitting that they have done so, expecting them to learn from their mistakes.

14 Make sure that subordinates understand the methods being used to measure their performance and invite their participation in measuring the results they are obtaining.

Conclusion

This is only a partial description of an effective boss—partial in that it deals only with his attitudes toward people and work and with the kinds of action he takes to motivate his organization. Motivating is only part of the boss's job—he must also work steadily and effectively at planning, organizing, and measuring results. These managerial attitudes and actions are not a substitute for doing these tasks well. On the contrary, genuine success in releasing the talents and energies of subordinates will require *more* planning, *better* organizing, and *more accurate* measurement of results than ever before.

[1] Adapted from "The Art of Administration," by Ordway Tead, McGraw-Hill Book Company, Inc., New York, N. Y., 1951.

With the machine tool taking on complex functions —made possible by numerical control

—tools and machines were developed together, neither handicapped by predesign of the other

By Robert K. Sedgwick,[1] Kearney and Trecker Corporation, Milwaukee, Wis.

THE sudden incursion of the numerically controlled machine tool into the field a few years ago stimulated development to an abnormal degree. Many companies previously concerned only with more or less "standard" hand-controlled machine tools developed designs either adaptable to numerical control or produced specifically for it. In many such cases, the control was applied only to the forces operating the slides of the machines in order to produce the proper orientation of the work with respect to the spindle. These arrangements became particularly popular in the milling-machine industry, where simultaneously controlled motion of three, four, or even five axes permitted the milling of quite complex shapes, completely beyond the capabilities of a human operator.

The acceptance of the multiaxis milling machine and other types of machine tools operating from the basic control mechanism was almost instantaneous. It was not long before systems adaptable to machine tools were available on a prepackaged, and even modular, basis. The co-operation between the machine-tool designers and the control-system and hardware people was intense, successful, and profitable. The buyers were alert to the possibilities for production gains, and spent large sums in training their personnel to extract the maximum benefits from the new technique. In some industries, the production of nonrectilinear shapes came out of the domain of the impractical and became commonplace. In others, already committed to the manufacture of such shapes, output rates were increased fivefold, scrap was reduced, and other benefits realized to such a degree that many production specialists felt that the ultimate had been reached.

As soon as the immense practical value of the numerically controlled machine tool became well established, the possibility of utilizing the principle in trying to attain that ever-sought goal, the automatic factory, was considered. Complete automation of all the functions of a machine, rather than limitation to the motions of the feed slides, would be a step in that direction, and a development program was launched.

Initial Phase—Setting the Specifications

The determination of the exact nature of the proposed machine was not the logical and scientific procedure that might be considered desirable. Layouts were started immediately, so that even during the preliminary discussion period there were drawings to discuss and evalu-

[1] Assistant Chief Engineer, Servo Machinery Division.

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TOOLS AND MACHINES

Simultaneous Development

Originally, solid coding collars with a ring pattern on the OD served as the basis of a binary coding system

Three assembled holders with tools and code rings illustrate the coding system. **Left to right,** floating tap holder, straight-shank drill holder, and a shell end mill holder are shown.

Later, individual code rings were substituted. These could be assembled in any desired order to incorporate all 961 tools. Large rings made an "and" signal, and small rings a "not" signal.

ate, while better ideas were sought. This procedure almost resembled brainstorming with illustrations, but out of it there grew, gradually, a set of tentative specifications to govern the first serious design efforts, which were to have the following features: (*a*) Numerical (in this case, tape) control of three axes of rectilinear motion; (*b*) tape control of the spindle, for both speed and direction, including rapid reversal for tapping; (*c*) capability of using many different tools carried in a magazine; (*d*) provision of a device to insert the proper tool in the spindle when so directed, and to replace it in the magazine when no longer needed; (*e*) shuttle and pallet loading, so that setups could be made away from the machine without consuming machine time.

The first two functions were to be under conventional full-servo tape control, while the remaining functions were to be under semiautomatic cycle control, specified and initiated by tape signals of the "intermittent-function" type.

It was recognized immediately that the tools used would have to conform to some very definite limitations as to size, shank configuration, power consumption, speed requirements, and dimensional fidelity. The exact design of the spindle and its tool-holding device would depend on the final tool-shank configuration; therefore the spindle and tool were always shown on the same layout.

Determination of Spindle and Tool Details

The established working dimensions of the machine implied limitations on the maximum size of usable tools. The arrangement of the magazine set a limit of $2^{5}/_{8}$ in. on the diameter of any tool, and a limit on over-all length of $7^{1}/_{2}$ in. It was decided that the largest drill would be 1 in-diam and the largest tap would be the 1-in. 8-thread. These dimensions were determined by considerations of available speed and torque. In addition to drills and taps, it was desirable to have end mills, small face mills, reamers, counterbores, single-point boring bars, and special multiple-diameter tools that would fit within the space and power limitations. The problem resolved itself into: (*a*) How to hold all these different tools in one spindle; (*b*) how to get them in and out without catching; and (*c*) how to transmit the necessary torque without keys.

About this time, an important decision was made with regard to the method of selecting the tool automatically. It was recognized that the placing of each tool in a

certain preassigned place in the magazine would place an undue burden on the operator and increase the likelihood of error. Also, the tools would have to be rearranged at each change of setup.

Instead, it was suggested that each tool should have a coding device mounted on it to permit some automatic-search device to seek out the tool, no matter where it might be. A system of coding rings, comprising the basis of a binary coding system, could be placed on the shank of each tool, and these rings could be sensed by a reading mechanism as the magazine was slowly rotated. Discussion revealed the essential soundness of this principle, and immediately the designer had one more task presented to him—in order to receive the coding rings, all the shanks would have to be the same size.

An over-all requirement from the beginning had been that the machine should use standard tools, picked from regular catalogs. These have shanks of every conceivable diameter, from too small to too large.

At this point, the firm decision to mount each tool in a separate holder with the coding collar mounted on the outside of the holder made the whole scheme practical. This also solved the problem on how to hold the tools in the spindle. The spindle would have a single hydraulically operated collet, which would grip the holder, and each holder would have its own internal collet or other suitable device for holding the tool.

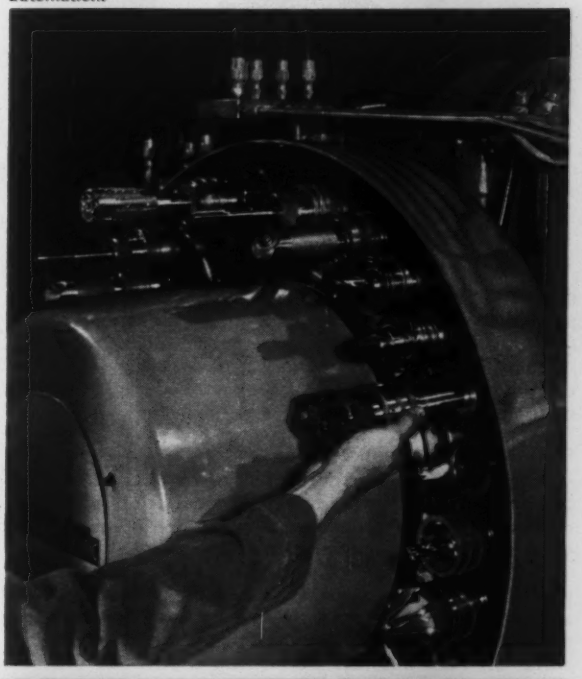
The first acceptable tool holder consisted of a hollow shank sized to fit the spindle collet, an internal collet that could be selected to fit any tool, and a coding collar with the ring pattern turned on the outside diameter. The collar also functioned as a nut to tighten the internal collet and as a gripping surface for the tool-changing mechanism. This design provided a standard gripping surface for the spindle collet at the back of the shank and enabled all the tools in the magazine to be transferred into the spindle without subsequent adjustment. Tools were to be preset in the holders, and a shoulder on the shank just aft of the collar was to seat against a bumper plate on the spindle. Thus, when installed in the spindle, the tool would project the same amount each time. Presetting was to be done off the machine.

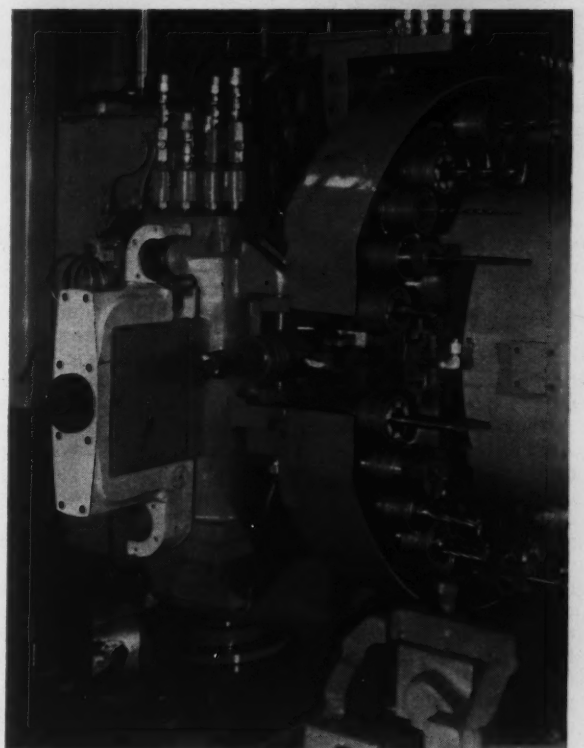
Two additional types of holders were developed. One was a tap holder in which the tool-holding collet was mounted on a floating stem. This provided for a slight longitudinal motion in case the tap should fail to pick up its lead immediately upon contacting the work. It also sensed the "no-hole" condition and shut the machine down without breaking the tap. The other was a holder with a projecting arborlike stem for mounting shell end mills. It resembled what is known as a type-C milling-machine arbor.

This was the state of the program at the time the first machine was ready to go into operation. Simultaneously with this effort on tool development, a much larger effort was put into the design of the machine itself and of the control cabinet which was to direct all the machine functions from original signals fed in by punched tape.

Tryouts of tool and machine revealed two shortcomings of the tool holder as originally made. The coding collar, also used as a locknut for the internal collet, would not tighten up to the same place every time, because of necessary manufacturing tolerances and variations in the tool-shank diameter. The other was that, since it was planned to code for as many as 961 tools for the whole system, many different collars

An operator inserts a shell end mill and holder into the 30-tool magazine. Milling, drilling, reaming, tapping, and boring operations are performed, bridging the gap between job-shop mechanization and automation.





In the transfer position, the tool is turned at right angles and projects, waiting to be gripped by the tool arm and transferred to the actual working position

might be required, plus spares. The failure to tighten up to the same point each time resulted in faulty positioning of the coding collars with respect to the reading mechanism, and the large number of collars required for the whole possible family of tools looked discouraging, if not prohibitive.

Final Configuration and Results

Both problems were neatly solved by eliminating the coding collar and replacing it with a series of individual rings stacked on the outside of the holder in any desired order. A large ring makes an "and" signal, while a small ring makes a "not" signal. These rings can be purchased in quantity and stacked on the tool holder at the time the tool is set, to make up any combination desired. It is no longer necessary to stock an individual collar for each number. To satisfy the former locknut function of the collar, an internal nut is installed in the front end of the holder and tightened with a spanner. The alignment of the coding rings is not subject to variations due to differences in tool-shank size, while the internal locknut may be torqued to whatever value is needed to hold any particular tool. The rings, of course, also fit the tap holder and the arbor-type holder.

This system has worked out so well that it has been expanded to include special holders for compound tools, multiple-bit fly-cutters, grooving tools, and even those in which the holder and code-ring configuration is turned integral with the tool shank. Some of these tools are so large that they will not fit into the magazine and have to be inserted in the spindle by hand. This is considered an acceptable procedure, provided the nature of the cut does not overload the spindle, and further provided that the operator has adequate protection against installing these manually inserted tools at the wrong time. This is taken care of in the tape and by the visual readout on the control console, which the operator can use as a reminder.

Throughout the entire program there has been a high degree of co-operation between the machine-tool manufacturer, the control-engineering group, and the makers of the tool holders. Almost every facet of this unified manufacturing system has required exchange of information between the three parties to the project, and many meetings have been held to settle the mutual problems. In almost innumerable cases, suggestions from one of the three have resulted in immediate changes in the course of action pursued by the others. The opinions of customers were sought, and many useful application data were gathered in this way. Most of the experimental cutting has been done on customers' workpieces. This has yielded the highest possible percentage of practical tooling information. Customers' tool specialists and production men have almost invariably co-operated in working up tooling and programs for running acceptance tests. The benefits of this kind of approach can hardly be overestimated.

The existence of a well-integrated tool program was a major factor in the wide acceptance of the whole resulting automatic-machining concept. One of the principal problems in getting any new kind of machine tool into the market in quantity is always the suitability of present tools or the ready availability of the new types. In the present case, the demonstrated adaptability of these new tool forms and the immediate presentation of large quantities for sale have done much to allay the otherwise natural fears concerning shortages, long delivery, and unknown quality. The current satisfactory situation is due to the crash program inaugurated by the tool-manufacturing companies and their readiness to discuss small problems before they become large ones.

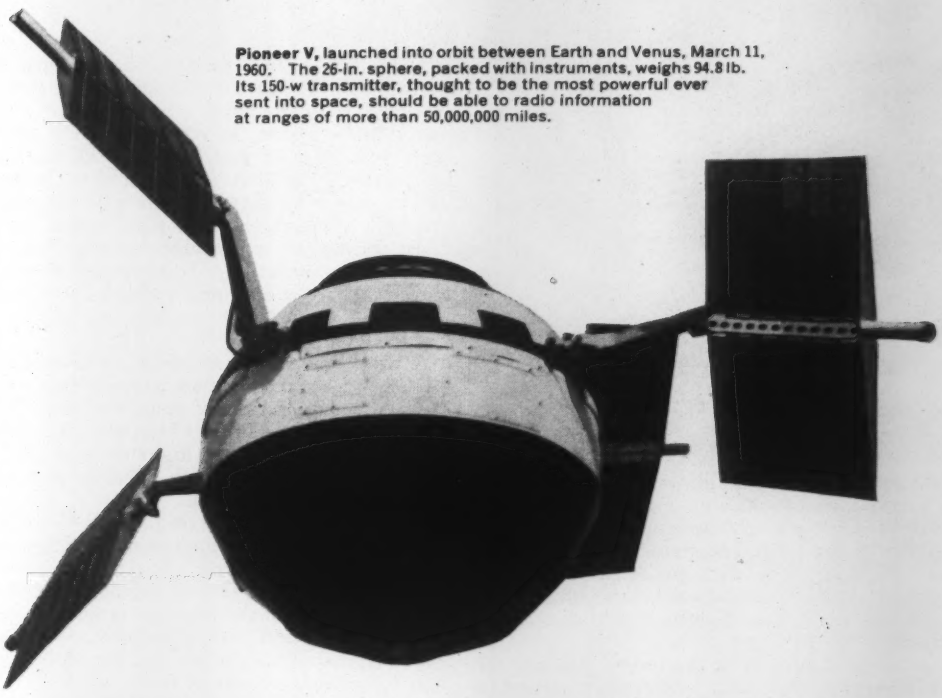
Evaluation of the Method

Simultaneous development of a machine and the tools for it would be expected to produce superior results in two ways: (*a*) Each of the two could be designed to take advantage of the most modern features available, without the handicap of any preassigned limitations due to the characteristics of the other. (*b*) The release of both designs can be held until both are considered satisfactory, and changes can be incorporated right up to the last minute. In these respects, it may be said that the whole project can be carried on with a minimum of waste.

However, the total amount of work required to complete the two designs was in excess of what would have been normally required. Because the entire program was so radical in basic principle, most of the relevant mechanical elements were almost unprecedented. Each element had to be developed from an extremely meager technical inheritance. The inevitable result was a large number of changes in "midstream," since every new suggestion that could be shown to be a positive improvement was incorporated. Many of these changes involved both machine and tool, and made necessary the wholesale scrapping of completed layouts.

In general, it may be said that the simultaneous technique can be justified where the anticipated sales volume of the resultant equipment warrants the number of engineering hours that are necessary, and where the degree of advancement produced is such that there is not the often-present need for racing against the efforts of one's competitors.

A producibility study was carried on during the manufacturing of the first few lots, with the result that many changes were incorporated in the design. This, too, must be included in any evaluation of the total effort. In the case described, the degree of acceptance by the machine-tool-buying contingent of industry has amply warranted the adoption of these procedures. The degree of success attendant upon these efforts has been so gratifying that it has been decided to utilize the producibility-study technique for future designs during the manufacture of the first unit, so that the benefits of the resultant economies can be made available with the first production run. It is felt that only by such methods may the use of the fully automated flexible-program machine be expanded to the largest possible degree.



Pioneer V, launched into orbit between Earth and Venus, March 11, 1960. The 26-in. sphere, packed with instruments, weighs 94.8 lb. Its 150-w transmitter, thought to be the most powerful ever sent into space, should be able to radio information at ranges of more than 50,000,000 miles.

THE EXPLORATION OF SPACE

By H. L. Dryden, Fellow, ASME, Deputy Administrator, National Aeronautics and Space Administration

Dr. Dryden reports on the NASA. The Agency's mission includes the exploration, investigation, and utilization of space and the development of space vehicles for these purposes.

THE Congress of the United States has declared that "it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind," and has established a new governmental agency, the National Aeronautics and Space Administration, to implement that policy. NASA has formulated specific national objectives in space and has placed before the Congress a plan for the next ten years of space exploration.[1]

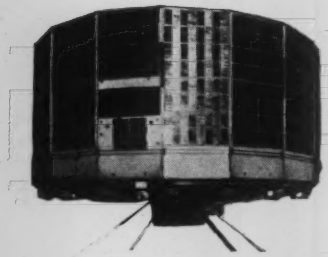
Space Environment

One major objective is the scientific study of the space environment and celestial bodies to gain new scientific knowledge. We seek especially to know more about the control exerted by the sun over events on earth, the origin and workings of the universe, and the origin of life.

As a typical project, consider the space probe Pioneer V, launched March 11, 1960. The probe which weighed about 95 lb was launched at a burnout velocity of 24,869 mph, nearly seven miles per sec, into an orbit about the sun inclining inward toward the orbit of Venus. Pioneer V will approach within 74,700,000 miles of the sun, which is about 18 million miles closer to the sun than the earth's orbit. It carries instruments to measure charged

[1] NASA is also charged with the responsibility for the conduct of aeronautical research necessary to the continued advancement of both civil and military aviation.

Based on an address delivered at the Dinner of the Applied Mechanics Summer Conference, Pennsylvania State University, University Park, Pa., June 20–22, 1960, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.



Tiros, with TV cameras to take still pictures of Earth's cloud cover

THE EXPLORATION OF

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particles in space, cosmic rays, magnetic field, micrometeorites, temperatures of various parts of the probe, and attitude of the probe.

About two weeks after launching, when Pioneer V had reached a distance of five million miles, there was a sudden burst of solar activity accompanied by severe magnetic storms at the earth, communications blackout, and auroral displays. The data obtained overturned well-established theories about solar-flare effects and provided new information on the structure of the earth's magnetic field.

A typical scientific mission of the future, planned for 1963, is an orbiting astronomical observatory carried in an earth satellite above the earth's atmosphere which is opaque to much of the radiation reaching the neighborhood of the earth from outer space. The telescope is to be stabilized and capable of being remotely pointed to any region of the sky. We await with great interest the first view of the sky in the ultraviolet region and the interpretation of the results by astrophysicists.

Another major specific national objective of the space program is the early application of earth satellites to immediately practical uses for human benefit. The major areas of application will be to meteorological research, weather observation, and weather forecasting, and to long-range radio links of great traffic capacity.

Tiros I

Our most successful current project is Tiros I, the meteorological satellite, which made 878 trips around the earth in its first two months, producing approximately 28,000 photographs of cloud formations over the earth between latitudes 50 deg N to 50 deg S. Tiros I was launched on April 1, 1960, and used television instrumentation. It is a 270-lb satellite launched into a nearly circular orbit with maximum and minimum altitude of 468 and 435 miles, respectively. The period is 99.15 min. It is stabilized by spinning, thus maintaining a nearly fixed direction in space. Pictures are obtained in that part of the orbit where the camera sees the sunlit portion of the earth. The satellite is provided with tape recorders which can record as many as 32 pictures for later transmission when the satellite is within range of one of the two ground stations.

Meteorologists tell us that the value of these photographs to their work has greatly exceeded their already high expectations. For example, in the southern ocean areas where previously the only observations were those from less than a dozen ships, Tiros produced pictures which gave an over-all view of cloud formations, showing the exact locations of four storm centers. Weather fronts were easily located. Previously unknown spirally banded cloud formations in storms of moderate intensity were seen for the first time, extending over thousands of square miles.

A future mission, in which we have attempted one launching without success, is the ECHO passive communications satellite. This satellite is an inflatable sphere, 100 ft in diam, which will constitute a small "moon" from which radio signals may be reflected to make preliminary experiments on wide band transcontinental communication. It is hoped that a successful launching may be obtained within a few months.[2]

Man In Space

A third national objective is to determine the capabilities of man to contribute to space exploration, and to begin the exploration of space by man. The current project is known as Project Mercury. It is expected that a suborbital or ballistic flight of man will be accomplished during the present calendar year, and orbital flight in calendar year 1961.

The next specific program in manned space flight will be directed toward the goal of manned flight around the moon and return to earth, a goal which seems possible of attainment near the end of the decade. However, the results obtained in the Mercury program will greatly affect the course and pace of manned space flight. If, for example, it should turn out that the effects of weightlessness for periods of several hours are such that a man is unable to perform such functions as communication, navigation, attitude control, etc., space travel of man would have to await the development of Saturn or later launch vehicles which could place in orbit large spacecraft in which gravity could be simulated.

We do not yet have launch vehicles suitable for many of the missions we would like to undertake, and hence a major segment of the ten-year plan deals with the progressive development of launch-vehicle systems of increasing capacity. Under development by NASA are: the Scout, a four-stage launch-vehicle system using solid propellant rockets; the Centaur with Atlas first stage and a second stage utilizing liquid hydrogen and liquid oxygen; and the Saturn with a first stage powered by a cluster of eight existing engines having a total thrust of $1^1/_2$ million lb and with a series of upper stages utilizing liquid hydrogen and liquid oxygen.

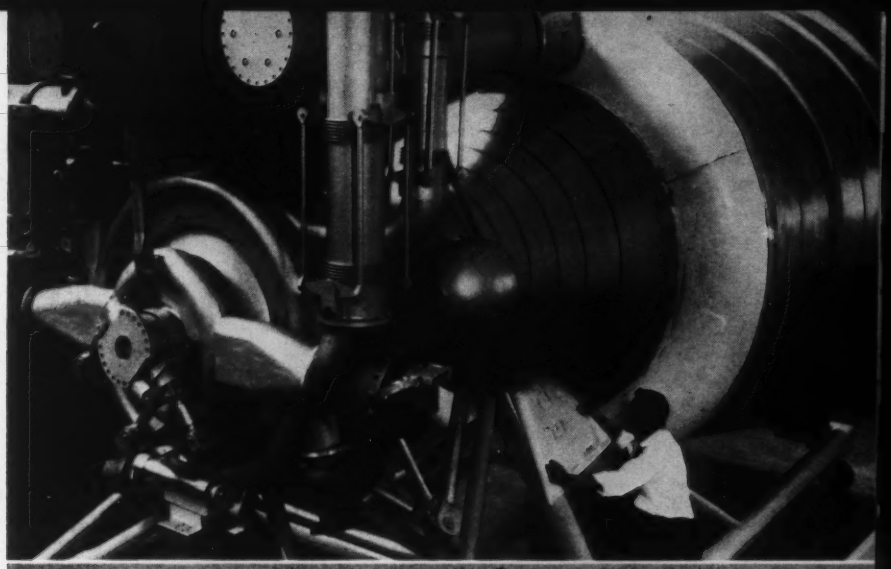
In addition, NASA is developing a single-chamber $1^1/_2$-million-lb-thrust engine for use in later vehicle systems and, in co-operation with the Atomic Energy Commission, a nuclear rocket for use in an upper stage of Saturn. Together with Thor-Agena B and Atlas-Agena B developed by the Department of Defense, five launching vehicles will support all the missions after FY[3] 1963, the Juno II, Thor-Able, Atlas-Able, and Delta systems now in use disappearing from the program as Thor-Agena B, Atlas-Agena B, Centaur, and Saturn become available. This ten-year plan of development of launch-vehicle systems provides an increase in weight of the largest spacecraft that could be launched from 150 lb in FY 1959 to more than 50,000 lb by FY 1967.

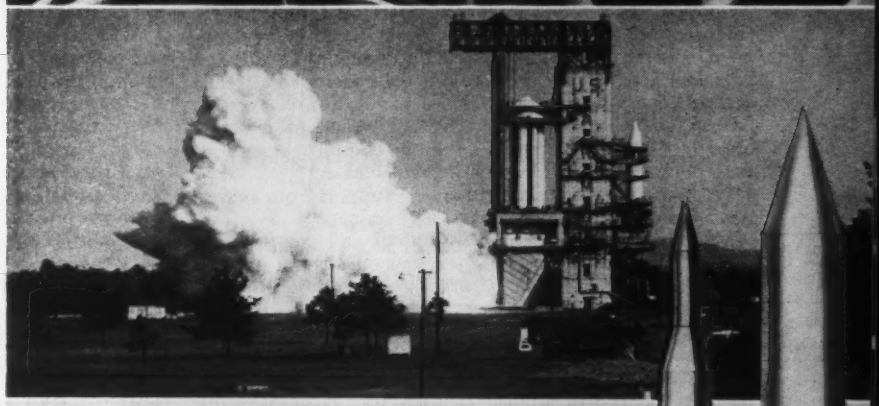
Instrumentation and Computation

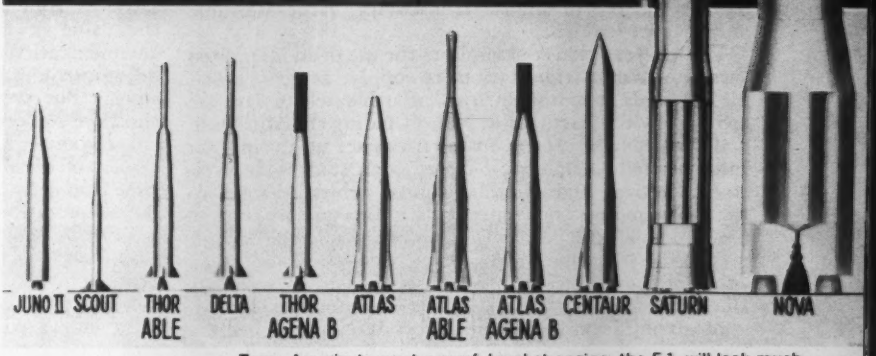
For each flight mission, there must be developed the spacecraft carrying the instrumentation and other apparatus required. All spacecraft must be provided with radio transmitters of suitable power for telemetry

[2] ECHO was successfully launched on August 12, 1960.

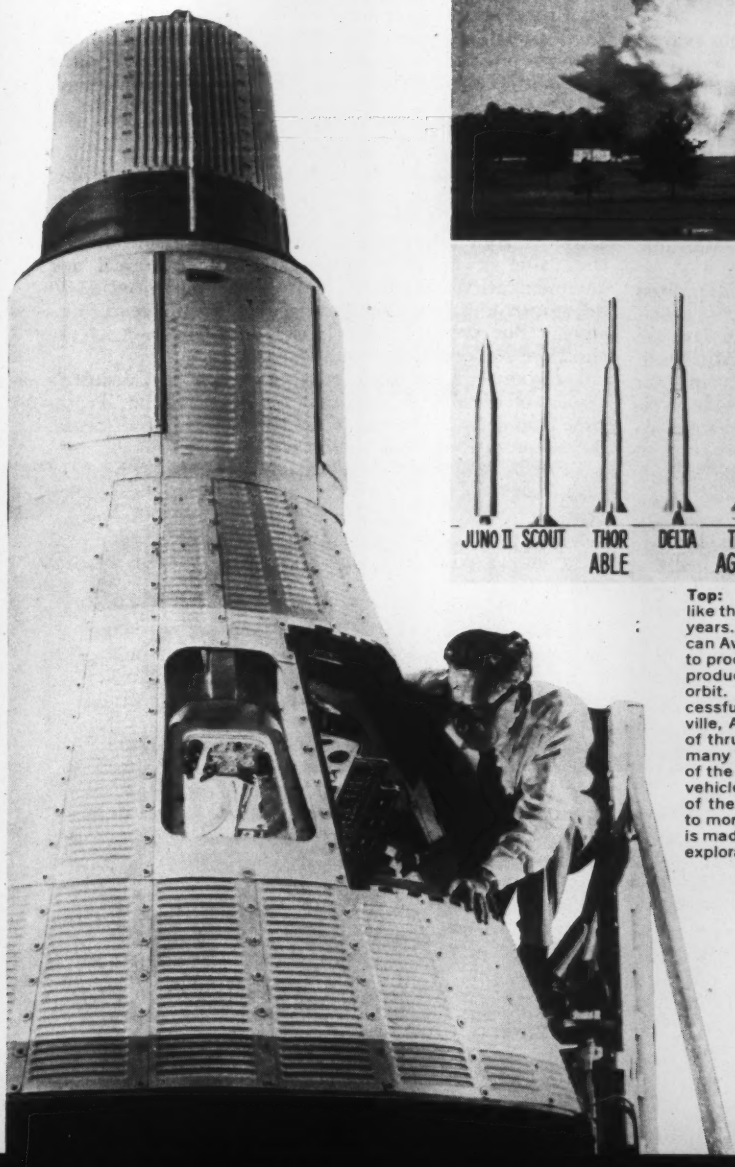
[3] Fiscal year.



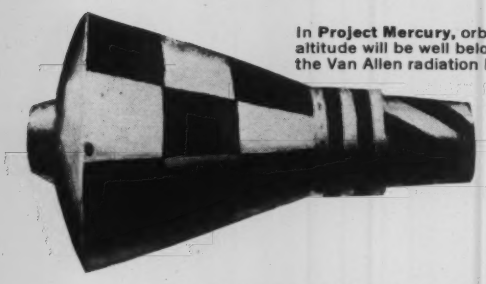




Below: Project Mercury ballistic capsule, designed for man's first exploration of space



Top: America's most powerful rocket engine, the F-1, will look much like this early full-scale mockup when it is ready for flight in about four years. Under development by Rocketdyne, a division of North American Aviation, Inc., for NASA, the single-chamber F-1 engine is designed to produce 1.5 million lb of thrust. When clustered, the engines would produce 9 million lb thrust, and place 150,000 lb of payload in an earth orbit. **Center:** One of a series of Saturn static tests, conducted successfully at NASA's George C. Marshall Space Flight Center in Huntsville, Ala. The big 8-engine booster developed more than 1,300,000 lb of thrust. **Bottom:** We do not yet have launch vehicles suitable for many of the missions we would like to undertake. A major segment of the 10-year plan deals with the progressive development of launch-vehicle systems of increasing capability, providing an increase in weight of the largest spacecraft that could be launched from 150 lb in 1959 to more than 50,000 lb by 1967. In support of the entire plan, provision is made for basic research in all branches of science pertinent to space exploration.



In **Project Mercury**, orbital altitude will be well below the Van Allen radiation belt

THE EXPLORATION OF

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of data to the ground, and, if manned, for voice communication. All require a source of internal power. At present, batteries and solar cells are used, and nuclear reactors with turboelectric generators are under development. Some spacecraft require a working fluid and auxiliary jets or auxiliary rockets for control of attitude or spin, or to modify the trajectory. Radio receivers to receive command signals from the ground may be required. The development of large complex spacecraft for beyond 1965 will be a major undertaking.

Each space-flight mission requires support from a suitable network of ground stations connected by communication lines to a central control and computation center. Equipment at these stations consists of optical, radio, or radar tracking apparatus to determine the trajectory of the spacecraft as a function of time, and telemetry receivers, radio transmitters to send command signals, and similar equipment. For the tracking of spacecraft at distances of millions of miles and for wide-band telemetry of high-data capacity, large steerable antennas are required.

The ten-year plan contemplates the use of an integrated system of world-wide stations to supply, as far as possible, all needs at minimum cost. Earth-satellite data are received by the Earth Orbit Net, including the Minitrack and Baker-Nunn camera installations set up during the International Geophysical Year, with some added stations to cover high-angle and polar orbits. Probes to the moon and beyond transmit their data and are tracked by the Deep Space Net. The manned satellite, Mercury, requires a special net because of the low altitude and other technical factors. Most stations of this net are constructed so that the equipment can readily be moved.

No exploration in human history has so stretched the imagination of man. The large distances involved, long known to us from the work of astronomers, strike us with new force as we consider traversing them. Our nearest neighbor, the moon, is about 240,000 miles away on the average. The nearest planet to us is Venus, 26 million miles; the next Mars, 49 million miles away. The farthest planet, Pluto, is 3680 million miles from the sun. The sun itself is 93 million miles from the earth.

The Need for Leadership

The broad horizons of space opening before us have emphasized the need for leadership in almost every aspect of life. Not only in technology do we find this need, but also in education, government, industry, law, ethics, and religion. In this discussion we are concerned with the implications for engineering and engineers.

First we find increased pressures to accelerate the tempo of changes in engineering education and practice which began during World War II. You will recall that there then arose areas of development in fields such as radar and nuclear energy which were inherently engineering in character. However, there were few engineers then available who knew enough about the scientific advances to exploit them. In addition, engineering developments in hitherto unexplored fields were found to be necessary.

Science and engineering became intermingled in a new breed of engineers, some being physicists and chemists who had absorbed engineering knowledge, some engineers of many branches who became knowledgeable of nuclear physics and chemistry. The best qualification that this new nuclear engineer could possess was a thorough knowledge of the basic principles of mathematics, physics, and chemistry. Similar experiences were encountered in aeronautical and guided-missile engineering.

You are familiar with individual leaders throughout the country who are taking the initiative in this matter of engineering education. An engineer who understands the basic principles of heat transfer can apply them to new situations in new technologies, to the cooling of a radar transmitter tube, a reactor fuel element, or even a satellite and its equipment in the space environment. Less specialization and a greater integration of basic scientific principles underlying all engineering application are essential to survival in a rapidly changing technology.

Exploration of Space: Will It Pay?

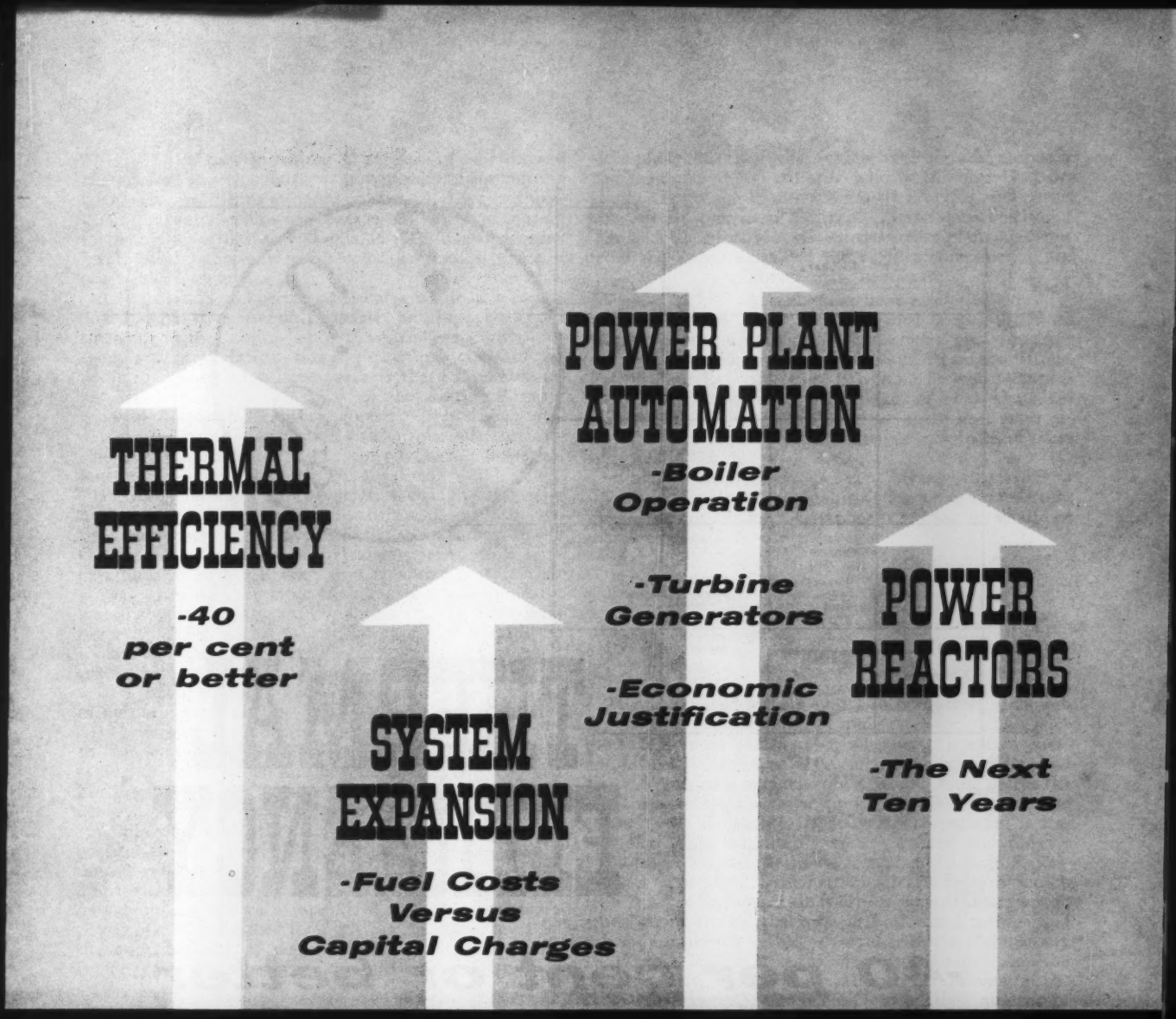
The exploration of space promises knowledge which can be exploited almost immediately for the economic and social benefit of man. The rich treasure returned is as gold from the new world in the seventeenth century, or spices from India, or furs from the far North. We see the value of the development of meteorological and communications satellites and of the advanced technology required for more and more difficult space missions. But probably the most important returns are those we do not and cannot now foresee.

I recommend to your reading Ralph J. Cordiner's discussion of the new frontier in his lecture in the "Peacetime Uses of Space" series of the University of California. A few quotations from his lecture:

"Every new frontier presents the same problem of vision and risk . . . Lief Ericson discovered America 500 years before Columbus, but apparently the Vikings did not have the vision to see anything worth while on that vast, empty continent, and so history waited another half millenium . . .

"When a new frontier is opened, the new territory always looks vast, empty, hostile, and unrewarding. It is always dangerous to go there, and almost impossible to live there in loneliness and peril. The technological capacities of the time are always taxed to the utmost in dealing with the new environment . . .

"It takes an immense effort of the imagination for the citizens to see beyond the initial difficulties of opening a new frontier. No one would pretend to foresee all the economic, political, social, and cultural changes that will follow in the wake of the first exploratory shots in space, any more than the people in the days of Columbus could foresee the Twentieth-Century world. But such an effort at prophetic imagination is what is required of us as citizens, so that we will not, like Lief Ericson, leave the making of the future to others."



POWER PLANTS -TOMORROW

This special section brings together reports from leading engineers, a symposium on the coming developments in the production of that prime commodity, power

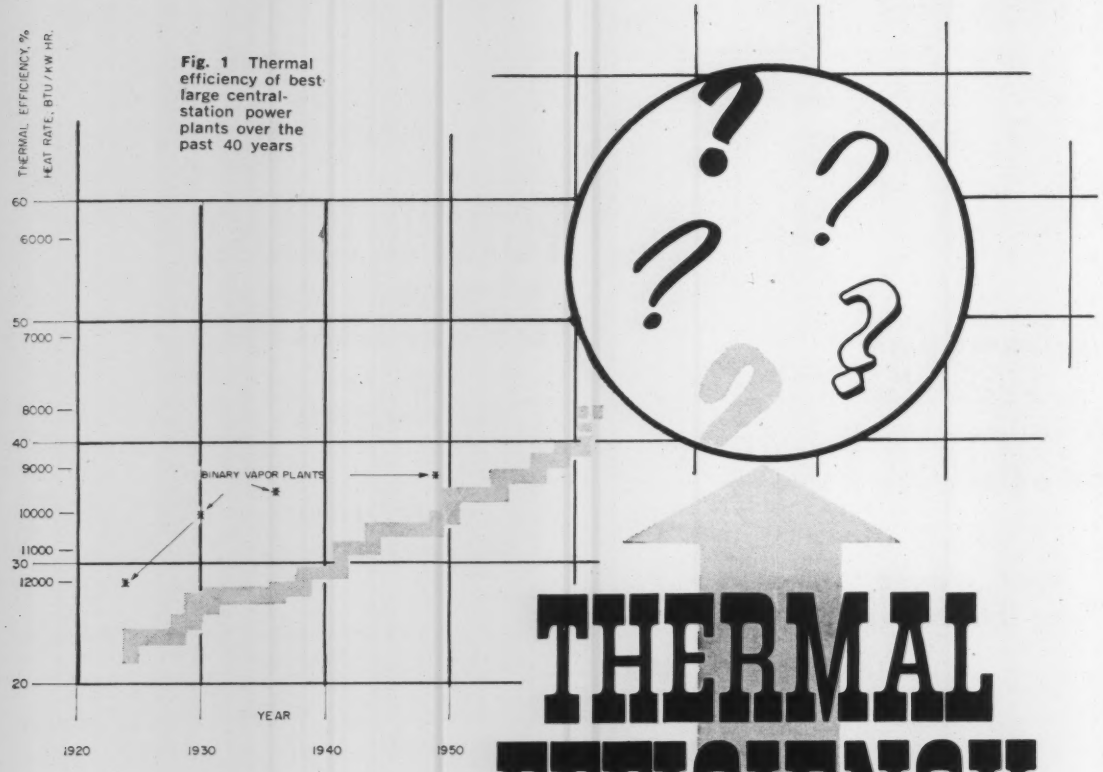


Fig. 1 Thermal efficiency of best large central-station power plants over the past 40 years

THERMAL EFFICIENCY

-40 per cent or better

By P. H. Knowlton, Jr., Fellow ASME
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Large Steam Turbine Generator Dept.
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While metallurgists work toward higher-temperature materials for the steam plant, there are other paths to higher efficiency. The problem is to choose the most fruitful line of development.

SOMETHING like 80 per cent of all electrical energy used in this country is now produced by burning coal, gas, or oil to produce steam to drive turbine-generator units. This percentage has been increasing for many years and now stands at its highest recorded level. The steam-powered electric-generation plant is practically supreme.

This position has been reached as a result of a steady development of greater unit capacity and higher thermal efficiency as the country's power system has grown. In today's central-station steam power plants, units are being installed which have the best thermal efficiencies yet attained, Fig. 1. In view of the continued rapid growth of installed capacity foreseen by various competent surveys, it is important to continue this thermal-efficiency improvement. The improvement, however, must not cost more than it is worth.

Thermal-efficiency improvement is brought about by higher inlet or lower exhaust temperatures, or both. In the steam cycle, higher average inlet temperatures in the Carnot sense are to be had by raising pressures or temperatures or both. Recent studies show that further advances would cost more than they are economically worth in fuel saving, although this may be only temporary. Other paths to higher efficiency should be looked at while the metallurgists work away at the crucial high-temperature-steam-plant materials problem.

It is possible that there never was a time when so many paths were visible. The ones to be discussed are: (*a*) The steam cycle alone, with various ramifications; (*b*) the binary-vapor cycle, for example, the mercury-steam cycle; (*c*) the hot-gas-steam combined cycle; (*d*) the hot-gas cycle alone; (*e*) the fuel cell; (*f*) thermoelectric devices; and (*g*) thermionic devices.

A quick look will be taken at the thermal-efficiency possibilities of these,[1] although such a broad survey cannot get very far into the details of any one, and the difficulties which might beset useful development have only been assessed very superficially. The large steam power plant has reached its present performance level by the contributions of many people over many years. Better types of plants cannot be evolved overnight.

Steam Cycle

On the wealth of published material on the theoretical and practical thermal efficiency of the steam cycle in its many forms, only the most efficient form is of interest. In recent years this has come to mean the reheat regenerative condensing cycle. The theoretical steam-cycle performance, Fig. 2, derived from Downs [1],[2] shows what the steam cycle can do for improvement from the theoretical and from the possibly practical viewpoint. Both viewpoints are important when comparing the present, practical, well-developed steam plant with possible plants of other types which have been developed to the same extent, or are still wholly in the laboratory stage. For comparison with other cycles and other conditions, some basis for extrapolation must be chosen. The over-all effectiveness E of the steam plant, made up from the "efficiencies" of the various components, and defined as $E = \frac{\text{Theoretical heat rate}}{\text{Actual plant heat rate}}$, will be used. Different plants have been designed and built with slighly different component efficiencies and therefore different plant heat rates with the same steam conditions. Downs (see Ref. [1], Fig. 10) chose for the 2400-psig 1050/1050-F steam cycle a heat rate of 6290, the plant effectiveness $E = 0.700$. He also shows heat rates extrapolated to higher steam conditions. A locus of these is shown in Fig. 2.

A plant effectiveness 2 per cent better—that is, $E = 0.714$—is considered reasonable under today's conditions by the present author. Component efficiencies would be distributed as follows:

	Per cent
Steam generator	90.0
Steam turbine	87.0
Electric generator mechanical losses	98.2
Feedwater cycle and heaters	97.5
Feed-pump loss factor	98.0
Other auxiliaries	97.0
Product E =	71.4

This is believed to be a typical distribution, although it may have been bettered in some cases by a small margin. It may be questionable whether this effectiveness could be maintained at very much higher pressures and temperatures in a manner which would make useful the full theoretical gain above present levels, of which the steam cycle is capable. Downs's extrapolation is less optimistic and admittedly more realistic for today's knowledge. Since the usefulness of much higher prestures is dependent upon metallurgical advances which have not yet been made, it is idle at present to argue too much about the exact design of boiler and turbine and other parts which would be required for a plant at say 10,000 psig, 1600 F, and the effectiveness depends on the design. Also, there are several possible variants on the cycle—for example, number of feed heaters, number of reheats, and boiler stack-gas temperature—which can make appreciable changes in the over-all thermal efficiency. In order to be reasonably sure not to "sell the steam cycle short" for the future, the extrapolation to higher steam conditions has been shown in Fig. 2 for the practical cycle at constant effectiveness, in addition to showing the Downs extrapolation.

The thermal efficiency obtainable with fossil fuel as a supplement to the nuclear plant is also shown in Fig. 2. The possibility of a high thermal efficiency in the use of fossil fuel arises from the present inability to generate superheated steam in large nuclear plants. Accepting this situation as a starting point, it is easy to show that heat added to the steam by burning fossil fuel for superheating and reheating can return a very good increase in power output per pound of steam flow compared to the heat input required for this heating. This results because the heat input is at a rather high average temperature and the heat rejection for the cycle is at condenser temperature. Also, there is a distinct improvement in turbine efficiency as compared with the machine using saturated steam. This is being done in one large plant

[1] Although there is room for difference of opinion, the relative thermal-performance figures to be given are believed to be correct for the assumptions made, and the assumptions are believed to be reasonably consistent with possible reality, unless otherwise stated. Only units of 150,000 kw and upward will be considered unless otherwise specified.

[2] Numbers in brackets designate References at end of paper.

Contributed by the Power Division and presented at the National Power Conference, Philadelphia, Pa., September 21–23, 1960, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS and the American Institute of Electrical Engineers. Condensed from ASME Paper No. 60—Pwr-4, originally entitled "A Look at Big-Power Cycles for 40 Per Cent Thermal Efficiency or Better."

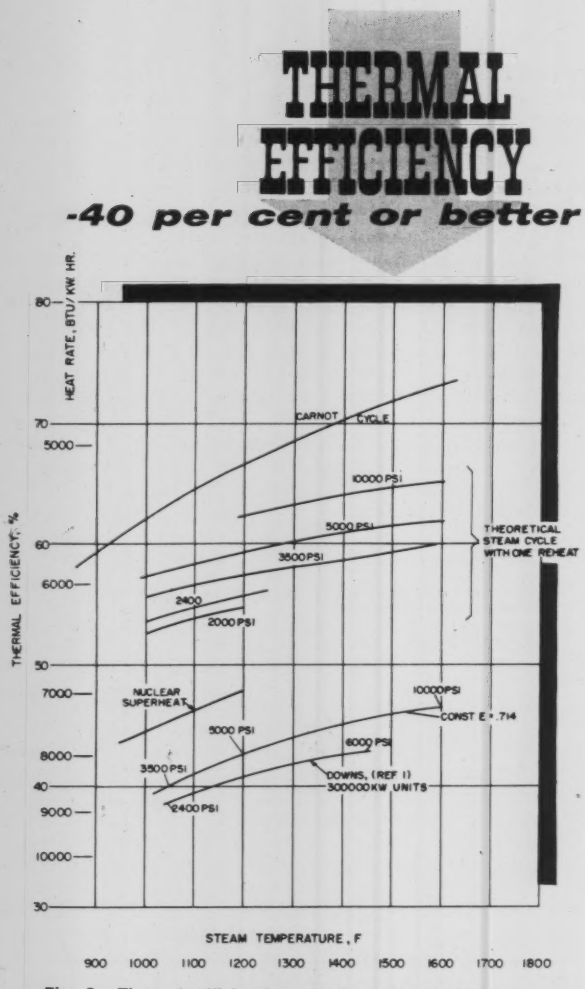

Fig. 2 Thermal efficiencies of reheat regenerative steam cycles (single reheat) as a function of initial and reheat temperatures (90-F exhaust temperature)

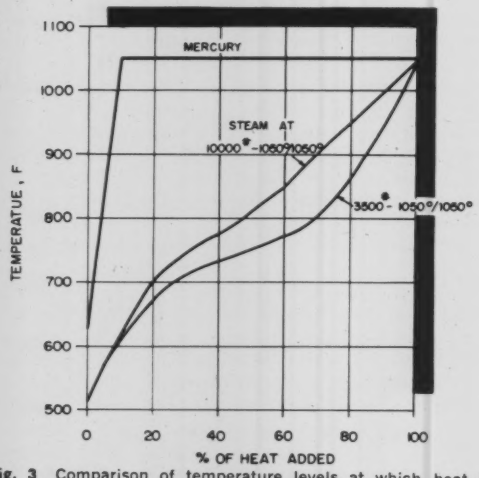

Fig. 3 Comparison of temperature levels at which heat is added for steam and mercury-steam cycles

now under construction [8]. The opportunity for this excellent efficiency will exist only so long as there is a lack of superheating-reactor apparatus.

Topping the Steam Cycle. Thermodynamically, the steam cycle suffers from having a large proportion of the heat input at less than the higher temperature even though a large part of the liquid heating is done regeneratively. This is because of the rather low critical temperature of water. There are two methods for "topping" the steam cycle temperaturewise, thus potentially offering thermodynamic gains. One is the binary-vapor cycle, and the other the hot-gas cycle. Each has apparent merits and demerits.

Binary-Vapor Cycles

The only binary-vapor cycle that has achieved a degree of practicality is the mercury-steam cycle. Over a 30-yr period from 1919 to 1949 several installations of this cycle were made [2, 3, 4, and 5]. None have been made since 1949. Three of these installations are still operating well. Points showing the thermal efficiencies achieved by mercury plants are plotted in Fig. 1. Because of the close approach of the working-fluid characteristics to those required by the Carnot cycle, this cycle is theoretically the most efficient known for a given initial temperature, Fig. 4. The striking increase in average heat-input temperature that is possible with mercury vapor as compared with even very high pressure steam, for the same top temperature, is illustrated in Fig. 3.

Other fluids than mercury, such as sodium or potassium or other rarer metals, could theoretically be used in place of mercury, with theoretically substantially the same practical performance. Those materials which have lower vapor pressures than mercury might be of some practical advantage for very high temperatures, since the boiler internal-pressure stresses would be rather negligible.

The mercury-steam cycles which have been put into use were limited to 950 F or less and to combined units of the order of 40,000 kw or less, with the steam superheating done by the fuel in the boiler. These plants were the most efficient of their day and have only been surpassed thermally by the largest, most modern steam stations, and further progress in arrangement and in top temperature would appear to be distinctly possible. At higher mercury initial temperatures a more efficient cycle could be set up, in which the steam superheating would be done by mercury vapor, thereby adding to the mercury-turbine output and the cycle efficiency. The plant performance shown in Fig. 4 assumes that this sort of cycle would be used. The practical efficiencies of the mercury turbine and boiler were pretty well proved by the plants built and operated, and the assumptions made in deriving the efficiencies shown for this type of cycle are in line with past experience. They are therefore believed to be about as realistic as the steam-cycle efficiencies.

In this cycle there is no particular merit efficiencywise in using a high steam pressure. It can be chosen to give a reasonable exhaust-volume flow for the mercury turbine, and the steam temperature need only be high enough to keep the steam-turbine exhaust-end moisture losses to a reasonable value.

The advantage of the binary-vapor cycle is, of course, its high efficiency. The main disadvantage is the rather high initial cost of mercury and the potential loss in

case of leakage. The practical performance of the cycle suffers somewhat from mercury-turbine efficiency levels of about 75 per cent, which is rather low, presumably because of high supersaturation and "moisture" losses since the whole expansion is in the "wet" region. In spite of this, and the necessary temperature-drop loss of about 30 F to transfer the heat from mercury to steam, the thermal efficiency realistically to be expected is very good. A practical problem might arise from the fact that, since all of the primary-fluid heat-transfer surface is at a high temperature, the only way to get the stack-gas temperature reduced to a satisfactory level is by use of high air preheat in the boiler. Unfortunately, from the simplicity standpoint, it is not practical to use mercury alone for the complete cycle, since its vapor pressure and density at final-exhaust temperature are altogether too low.

The Hot-Gas-Steam Combined Cycle

Utilizing the Gas Turbine. This cycle superposes the hot-gas cycle over the steam cycle temperaturewise, but in a different fashion from the superposing of the mercury (or other fluid) over the steam cycle in the binary-vapor-cycle arrangement. This superposition may be accomplished:

1 By exhausting the gas-turbine compressor to the steam-generator furnace, thus pressurizing the furnace, and burning all the fuel there, and leading the gas to the gas turbine when its temperature has been brought to a satisfactory level. The gas, after passing through the gas turbine, then has its temperature brought down to a throw-away stack temperature by a combination of air preheater and economizer and evaporative surface.

2 By burning part of the fuel in the combustion chambers of the gas turbine, and the remainder in the furnace of the steam generator.

3 By burning all of the fuel in the gas-turbine combustion chambers and exhausting the gas turbine to the steam generator, thus using the steam generator in place of a regenerator.

Obviously, all of the large number of theoretically possible combinations cannot be covered here. Several have been described in the literature (for example, [6] and [7]). The main objective is to make an arrangement which does not degrade the steam cycle thermodynamically. The gas-turbine-power output is simply superposed upon the steam-power output to get as much power as possible out of the gases which are primarily used for generating the steam. The thermal gain is proportional to the amount of net gas-turbine-power generated per kilowatt of steam-power output. This amount depends mainly upon the gas-turbine inlet temperature, the gas-cycle pressure ratio, the gas-turbine and compressor efficiencies, and the pressure-drop losses in the gas system. The calculated gains shown in Fig. 5 are to be expected above the efficiency level of the steam cycle shown in Fig. 2 at 3500 psig 1050/1050 F. Some other steam cycle could have been used as a base. The combined gas-steam cycle shows slightly more gain over poorer steam cycles, and slightly less gain over better steam cycles.

The gain over the steam cycle alone increases with increase in gas-turbine temperature, and with gas-turbine reheating, because both make it possible to get more gas-turbine power output for a given steam-power output. Present operating gas-turbine temperatures for power turbines are around the 1450-F level. Higher temperatures than this presuppose either the development of new materials which will maintain their strength at higher temperatures, or the use of some cooling means for the stressed parts exposed to the hot gases. This cooling will degrade the cycle, more or less, by removing some heat from the hot gases and transferring this heat to a lower temperature level. In the combined cycle this cooling could be done theoretically either by water or by air. Presumably with either cooling medium the total amount of heat to be transferred would be the same if the same metal temperatures are to be maintained. The amount of heat to be transferred also depends upon the turbine design, and since this has certainly not been worked out in detail, the amount of the cooling loss remains uncertain. It is assumed in

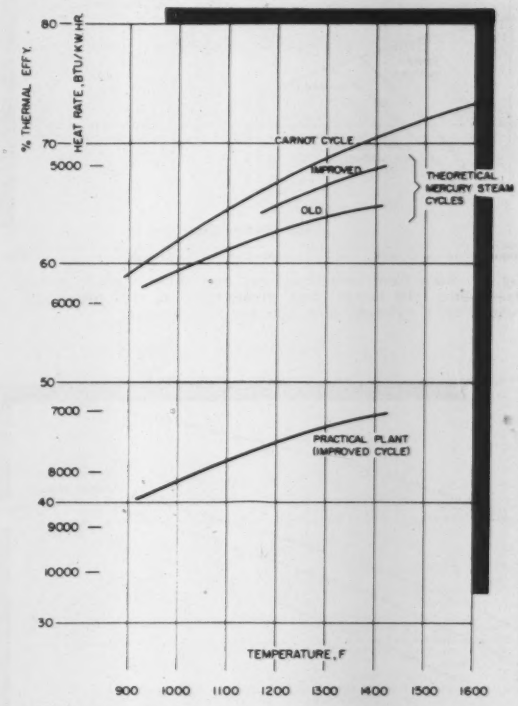

Fig. 4 Thermal efficiency of mercury-steam cycles versus initial temperature of mercury (90-F exhaust)

Fig. 5 that the cooling is done by steam condensate when cooling is required.

Utilizing the MHD Generator. A proposal to replace the gas turbine by a magnetohydrodynamic (MHD) generator is currently receiving attention. MHD generation requires an electrically conducting gas or vapor as a working fluid. This is made to flow between electrodes through a magnetic field. An electrical potential is generated and a direct current flows through the gas and electrodes to a connected load. Energy is removed from the gas equal to the electrical energy plus losses. The lack of moving parts makes higher temperatures appear practical because there are no stresses from centrifugal forces in the hot parts.

Superposing such a device over the steam cycle could

THERMAL EFFICIENCY

-40 per cent or better

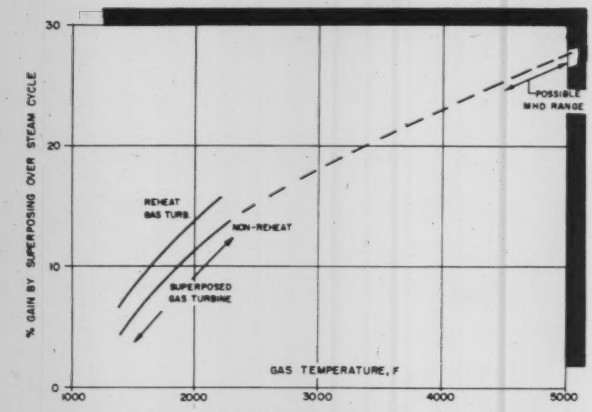

Fig. 5 Gain from combining gas and steam cycles, versus gas-turbine inlet temperature, steam cycle at 3500 psig 1050/1050 F (90-F exhaust, 80-F ambient temperature)

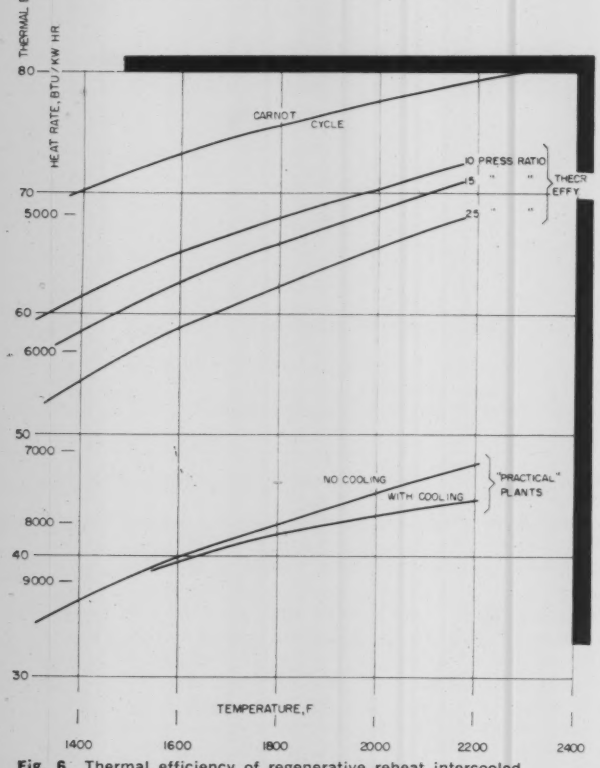

Fig. 6 Thermal efficiency of regenerative reheat intercooled gas turbine (single reheat) versus initial and reheat temperature (80-F ambient, 60-F cooling water)

theoretically be the equivalent of the combined gas-steam cycles already discussed. At present, as far as the author is aware, ordinary combustion gases can only be made electrically conducting at very high temperatures, that is, above 3500 F or so. The discharge temperature would also be at about this level, creating a problem of efficient use of the heat in these discharge gases. To avoid a very large temperature difference from the MHD exhaust to the steam-temperature level, with a consequent large thermodynamic loss, a gas turbine would have to be used to further reduce the gas temperatures before transferring their heat to the steam, or the heat would have to be transferred to a separate gas-turbine cycle through a heat exchanger. Apparently a large auxiliary-power loss is required to maintain the magnetic field which is a function of the design of the generator and in turn depends upon the gas properties. Also, presumably a d-c to a-c conversion would be required for power-plant use.

Although at such high temperatures the theoretical possibilities of MHD power generation are considerable, it seems wholly impossible at this time to make any well-founded predictions. In Fig. 5, it is speculated that the trend of gain from superposing over the steam cycle which is evidenced by use of the gas-turbine cycle might be continued to higher temperatures by MHD apparatus. Clearly a large development incentive exists if means can be found for getting thermal efficiency gains of this substantial magnitude.

The Hot-Gas Cycle Alone

The gas cycle can be used without any steam cycle under it. There are many forms of this cycle, of greater or less complexity. It can theoretically reach Carnot efficiency in one of two ways: (*a*) By having perfect isentropic compression and expansion processes, with a high pressure ratio and an infinitesimal heat addition at the end of the compression; or (*b*) by having an infinitesimally small pressure ratio, with an infinite regenerator, and a similarly small heat addition at the high temperature. Neither of these theoretical cycles has practical significance. The best approach to the Carnot cycle, in what would seem to be probably practical apparatus, is to use at least one reheat, with a large regenerator, and an intercooler to reduce the compressor-work input, and a total pressure ratio in the range from 10 to 20. The theoretical performance of this cycle is shown in Fig. 6 for three pressure ratios. This is a good practical cycle if the temperature is high enough and the components are of high efficiency, and the pressure-drop losses through the apparatus are low. In calculating a "practical" performance, the chosen assumptions for these components are as follows:

Assumed Component Efficiencies[a] and Losses, Per Cent

Compressor efficiency	88
Turbine efficiency	88
Intercooler effectiveness	92
Regenerator effectiveness	85
Total system-pressure drop	12
Combustion efficiency	98

NOTE: Ambient air at 80 F; cooling water available at 60 F.

[a] The machine efficiencies assumed are higher than are achieved by present gas turbines. The "practicality" of the performance figures is dependent upon some aerodynamic achievements as well as metallurgical advances.

For equal thermal efficiency with the steam cycle or the binary-vapor cycle, the temperature of the hot-gas-cycle working fluid must be higher. When using gas or treated oil as fuel, the high gas temperature is easily reached by "internal combustion" without having to transfer heat at the high temperature through metal walls. Coal is, however, the most prevalent fuel, and the ash and other undesirable constituents of coal seem to preclude its direct firing in this cycle by any presently known means. Because of the higher temperature required for the gas than for the steam to get the same thermal efficiency, there seems to be no reason to suppose that a closed gas cycle with a coal-fired air heater instead of the steam generator has anything to recommend it, even though this would eliminate the ash problem from the gas turbine itself.

Fuel Cell

The fuel cell, a d-c power source, generates electric energy directly from chemical energy. The temperature level may affect the chemical reaction but does not affect the thermal-efficiency possibilities of the device in accordance with the Carnot principle as it does in the usual "working-fluid" type of thermal cycle. Liebhafsky and Douglas [9] show that the fuel cell has very good theoretical possibilities for high efficiency in transforming heat energy to electrical energy, although another five years in the laboratory are required before an appraisal can be made. Efficiencies around the 50 per cent level or higher are in sight if the device can be developed.

Thermionic and Thermoelectric Devices

Possibly successful use of devices of these classes appears to depend upon materials developments of an entirely different character from those for extensions of the hot-gas cycles. Future laboratory developments may produce materials whose combination can raise the efficiencies of these d-c power devices above those of the present heat cycle, although this seems to be far in the future.

Conclusion

After this rather broad look around the thermal-efficiency scene, summarized by Fig. 7, one can only conclude that there is an enormous field for further progress in thermal efficiency. The major problem is to choose the most fruitful line for further work. There have been a few times in the past when there was a flat spot on the chart of Fig. 1 extending four or five years. This may be another, but there is plenty of reason to believe that it will be only temporary. Fig. 1 shows a reasonably steady progress of close to one-half point of thermal efficiency per year in getting up toward the 40 per cent level, which as far as the author knows has not quite been reached. Harlow's figure of 8016 Btu per kwhr [10] for the Philadelphia Electric Company's Eddystone No. 1 unit is at 1.0 in. Hg abs (79 F), but if it is realized in service, it will still be above the 40 per cent thermal-efficiency level when corrected to 90-F exhaust. It will be a real challenge to continue the progress above this level.

Acknowledgment

Thanks are expressed to the many colleagues who have been most helpful in the preparation of this paper. The calculations for steam, gas, and binary cycles have been based, as appropriate, upon:

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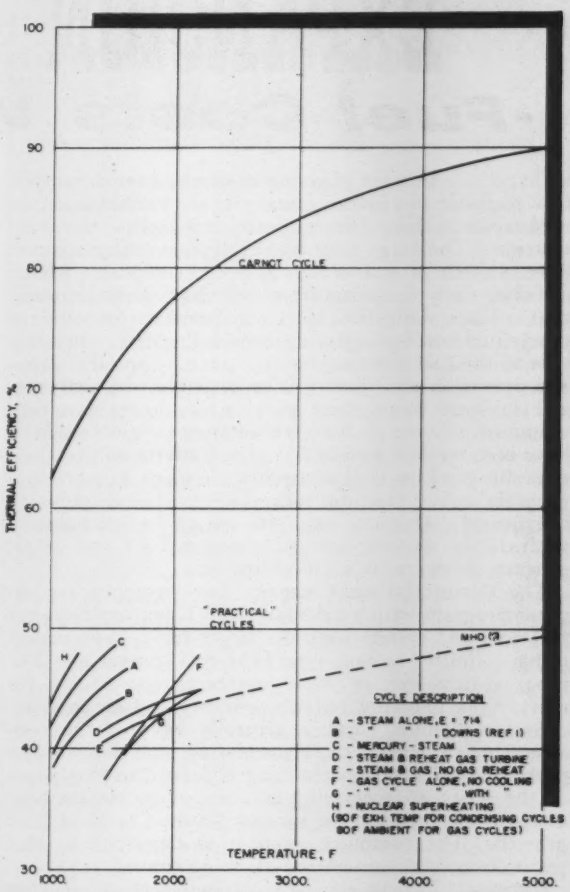

Fig. 7 Comparison of thermal efficiencies for various cycles, versus temperature

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SYSTEM EXPANSION -Fuel Costs Versus Capital

By W. J. Fahrner[1] and C. M. Heidel,[2]

Here is the averaging technique used by Detroit Edison in their computer-type program to answer questions on plant expansion

UTILITY planning engineers have developed new methods of analyzing many of the variables associated with adding future generating units to their systems. The large electrical-equipment manufacturers have written programs for electronic computers which calculate daily fuel costs from daily-load-curve information. These daily fuel costs are summed to provide a yearly fuel cost for a given generating system. In addition to the fuel-cost program the annual capital charges and operation and maintenance costs must be analyzed, and in some cases these two factors have been programmed. Some of the very detailed programs which have been written to date have the limitations that considerable machine time is required to run each individual program and a machine with a large storage capacity is required. If many variables are to be individually studied, the expense and time required by the detail program are excessive for most utilities.

The Detroit Edison Company has developed a computer program which calculates this Company's system fuel cost and system capital charges for a 35-yr period using a limited-storage-type IBM 650 computer. The program involves an averaging technique which, for most system planning, provides suitably accurate answers.

System-planning studies generally involve the consideration of generation, transmission, and distribution problems. Generation planning is defined in this paper as the study of generating-unit size, type, steam conditions, and location for various assumed rates of load growth. The computer application described in this paper covers only generation-planning studies.

Definition. Detroit Edison's original need to develop a computer-type program resulted from a desire to analyze in detail the many types of generating equipment presently offered for purchase. The era when large gains in efficiency could pay for additional capital costs appears to be temporarily at an end. Therefore all types of equipment ranging from very inefficient peaking-type equipment to very-high-efficiency supercritical double-reheat equipment have to be considered when analyzing equipment for future installation. At the present time, five general types of equipment are available and these are classified in Table 1.

Table 1 Types of Available Equipment

	Approximate operating heat rate, Btu per kwhr	1962 fuel cost, mills per kwhr	Plant cost, net kw, dollars per kw
Very-high-efficiency equipment (coal-fired)..	8300	2.6	152
High-efficiency equipment (coal-fired).....	9000	2.9	145
Low-efficiency equipment (coal-fired).....	10500	3.3	120
Peaking equipment.....	...	8–10	100–110
Nuclear equipment.....	...	2.5	250

An operating heat rate of approximately 8300 Btu per kwhr for the very-high-efficiency equipment would result from combining supercritical pressure with a double-reheat cycle. The combined steam-gas-turbine cycle in its various forms would also provide a very-high-efficiency plant. By definition, high-efficiency equipment includes primarily the 2400-psig 1050/1000-F single-reheat cycle which is prevalent in the United States today. Low-efficiency machines with heat rates of 10,500 Btu per kwhr and steam throttle conditions in the order of 1450 psig and 950 F might find justification at certain times in Detroit Edison's system. Thus this type of unit is included for appraisal. Considerable material has been written in recent months about the use of specialized peaking equipment such as diesel generators and gas-turbine generators as a desirable component of increased system capability. Stripped-down nonreheat gas or oil-fired steam-turbine generators and certain forms of steam by-pass turbines have been designed which provide capacity for a low incremental cost. The work would not be complete without a thorough investigation of the potential use of equipment which can be used for peaking service. Although there is no present economic justification for nuclear power plants, these have been included because the studies extended to when these plants presumably will be justified.

Program Variables. Obviously, generation-planning studies require an analysis of many variable factors: (*a*) System growth, (*b*) fuel cost, (*c*) system load factor, (*d*) system reserve margin, (*e*) heat rate versus load characteristics, (*f*) unit size, (*g*) plant-cost escalation, and (*h*) type of units in future system. Each of these parameters can be changed in the Detroit Edison program and the effect of the changes analyzed.

Description of Program

The approach for analyzing various types of system

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Assoc. Mem. ASME, The Detroit Edison Company, Detroit, Mich.

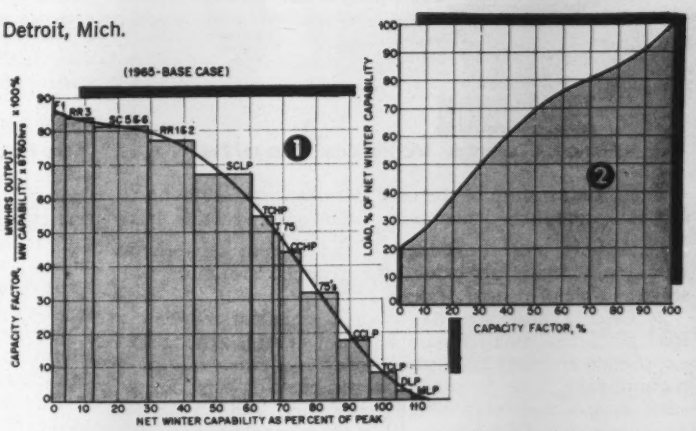

Fig. 1 The system capacity-factor curve is derived by plotting annual capacity factors of individual machines against their capability as a per cent of system net winter capability. The machine with the highest capacity factor was plotted at the left side of the curve sheet, and the balance of the machines are plotted to the right in descending order of capacity factor.

Fig. 2 To correct the design heat rate for the average load on the machine while running, load-duration information for typical units is plotted as a function of capacity factor

Charges

expansion is composed of two parts—the fuel-cost program and the capital-charge program. The expansion which results in a minimum sum of these two items is deemed the optimum, assuming all other factors (operating and maintenance costs) are essentially equal.

Fuel-Cost Program. The fuel-cost program computes the kilowatthours each machine or class of machines will produce in each year of the study. The energy output of each machine is then multiplied by its fuel cost. These fuel charges are then summed for the year and present-worthed to the first year of the study. The fuel cost can be maintained constant throughout the study or it can be increased every year to reflect inflation.

In order to compute annual kilowatthours for each machine, use is made of a capacity-factor curve. This was derived by examining the annual capacity factors for a number of years for Detroit Edison's existing generating units and then plotting these factors against their capability as a per cent of system net winter capability. The machine with the highest capacity factor was plotted at the left side of the curve sheet with the balance of the machines plotted to the right in descending order of capacity factor. These capabilities were cumulated and generally indicated that Detroit Edison's system uses approximately 15 per cent more capability than the winter peak if that much capability exists. Fig. 1 shows this curve with the various machines in Detroit Edison's system blocked in. The electrical generation represented by this curve results in a 60 per cent load factor which has been the case for this system for a number of years.

As could be expected, in most cases the order of the machines is determined by their efficiency. The most efficient machine obtains the highest capacity factor, the least efficient the lowest capacity factor. In some years due to unusual outages a machine may be displaced from its rightful position, but in every other instance it will assume its proper position in the loading sequence.

Since this is a historical curve, it accounts for scheduled outages, forced outages which have occurred, part-load operation, reserve time, and incremental loading of the present equipment. It is then assumed that these events will be repeated in the future thus making it possible to predict future machine annual energy output. This curve is programmed and fed into the computer which then fits all units, up to 115 per cent of winter capability, under the curve in order of merit.

To this point, only design-heat-rate information has been used; however, the design heat rate is corrected for the average load on the machine while running. This is accomplished by plotting historical load-duration information for typical units as a function of capacity factor. Such a curve is shown in Fig. 2. This curve is then combined with the heat rate versus load which is supplied by the turbine manufacturer (or test curve if available). The resultant curve is stored in the computer with its co-ordinates being machine capacity factor versus heat-rate correction, Fig. 3. With this correction the average annual operating heat rate of the machine is obtained. This correction provides a very useful tool in evaluating various sizes of last-stage blading. The items discussed to this point provide the basic components of the system-fuel-cost program.

Capital-Charge Program. In the capital-charge program the computer calculates the installation cost of the machine additions in the year they are installed, using the first-year quoted price (input data) and the escalation rate as set forth in the input data. It then multiplies this investment cost by the fixed-charge rate for each new machine installed in the system up to and including the year under consideration. These fixed charges are summed and present-worthed to the first year of the study. This procedure is repeated for every year of the study. The end result is the sum of the present worths of the annual fixed charges for every machine added to the system for the duration of the study.

Having the sum of the present worth of the annual system fuel cost and the annual fixed charges, a further step is taken to bring these numbers to level annual costs by multiplying these costs by a capital-recovery factor. Print-out data sheets are obtained for both the fuel costs and the capital costs.

Program Procedure. One of the expansions studied was that in which peaking equipment is installed at regular intervals. In order to evaluate this, a base program was established and the following input data were supplied to the computer: (*a*) Peak load for the first year, (*b*) annual load growth as a percentage of the annual peak, (*c*) size and design heat rate of both the present and the future generating units, (*d*) installation data of future units, (*e*) heat-rate correction-factor curve for these units, (*f*) fuel cost for each unit, (*g*) fuel-cost escalation rate, (*h*) duration of study (usually 35 yr), (*i*) first-year investment costs of future generating units, (*j*) investment-cost escalation rate, (*k*) fixed-charge rate, (*l*) present-worth rate.

The actual timing of the unit installation and the unit size is accomplished manually. The ground rules are:

1 A unit must be added if the system capability would otherwise fall below the assumed minimum reserve at time of system peak.

2 Once a unit size has been established for base-load machines, smaller sizes will not be used since past experience and this program have shown this to be uneconomical. This is not true for peaking-type units such as gas turbines, diesel generators, and stripped-down gas or oil-fired units since their investment costs per kilowatt are nearly constant regardless of size.

With this as input information, the computer arranges the units under the machine capacity-factor curve in order of their design heat rates and computes the capacity factors. Using this capacity factor the computer applies the heat-rate correction factor and then checks to see that the machines are still in the order of their efficiencies. If not, it rearranges the units under the machine capacity-factor curve and calculates new operating heat rates until the machines are in the order of their efficiencies. This being accomplished, the kilowatt-hours are computed and multiplied by the fuel cost, escalated to year under consideration. The fuel costs for all the units in the system that year are summed and present-worthed to the first year of the study. This process is repeated for every year of the study with the addition of future units as described in the input data.

The capital charges are computed for the expansion as previously described. The annual level fuel cost and fixed charges for the base program are obtained.

In order to evaluate the peaking expansion, the base program was modified so that 10 per cent (or any percentage) of the capacity additions were peaking-type units. Initially, the peaking units substituted for the base-load units were the same size; thus no deferment credit was obtained—only a straight comparison of fuel cost and fixed charges. In subsequent runs unit timing was altered to give the effect of deferment credit which is realized with the small peaking-type units. The level annual costs of this expansion were then compared to the base program.

Any of the parameters such as escalation, heat rates, investment costs, load growth, and similar factors can be altered in order to evaluate their effect. Care must be exercised not to favor any particular expansion.

Maintenance costs have not been considered in these programs because of the difficulty of determining incremental maintenance costs as a function of energy output. Furthermore, in most instances the maintenance costs will be very nearly the same for all programs and, therefore, do not affect either alternative. However, if known differences do exist, they are accounted for outside the program proper.

Unit-start-up costs have also been neglected. An examination of these charges indicated they are of relatively small magnitude.

These omissions should not change any of the conclusions, since many of the assumptions that are made in studies of this sort, that is, investment costs, heat rates, fuel costs, and so forth, will have much greater bearing on the results of the study.

Typical Problems

Long-Range Generation Plan. The program has proved very useful in answering questions related to generation planning. To properly analyze the fuel-cost credit or penalty for installing one particular machine or machine type versus another, a determination is made of the annual system fuel cost for each alternative for the life of the machine. The resulting difference in level annual fuel cost indicates whether the capital cost difference is justified. It can be seen from this that, in order to determine the annual capacity factor for these machines for each future year, a determination must first be made of the type and amount of equipment which will be installed in the Edison system in future years. For instance, installation of a large amount of low-efficiency peaking capacity will change the capacity factors of the high-efficiency equipment installed in 1965 by 8 to 10 per cent. In a similar manner the capacity factor of a nuclear unit will be affected by the amount of peaking, high-efficiency, and nuclear equipment which follows its installation. To approach the problem in a logical manner the following sequence of steps was established to analyze the system capacity requirements:

1 Determine the optimum percentage of peaking, coal-fired high-efficiency, and nuclear-type equipment to be installed in the 35-year period 1965–1999.

2 Determine the optimum installation schedule including size, type, operating conditions, and location of units to be installed in the 5-year period 1965–1969.

3 Determine the specific type and steam conditions of the machine to be installed in 1965.

Each step is followed and the results of preceding studies are included as background information for succeeding programs. As an example, if it is determined that 10 per cent of all future generation should be in the form of peaking capacity, then 10 per cent peaking capacity is included in the background when optimizing a 5-year installation schedule. As a result of this approach, a 35-year background generation expansion has been developed which includes peaking, conventional, and nuclear power plants. Preliminary results indicate that Edison's future system should have approximately 10 per cent peaking capability installed, based on the investment savings that this equipment can afford. The addition of peaking results in a substantial increase in annual capacity factor for the proposed high-efficiency machines and ultimately could lead to justifying further advances in steam conditions as shown in Fig. 4. The nuclear units in the expansion primarily would be installed in the 1970's and 1980's on the supposition that they will be economical at that time. This is done to measure the effect on the capacity factors of the units installed in the 1960's and to determine the capacity factors which the nuclear units could expect.

Five-Year Installation Program. Work is presently progressing on the development of a 5-year optimum installation program. This study involves a comparison of several plans in which the machine sizes, types, efficiencies, and location are interchanged. The particular delivered fuel cost, transmission investment, transmission-loss penalty, and operating labor cost associated with each machine addition are included. This type

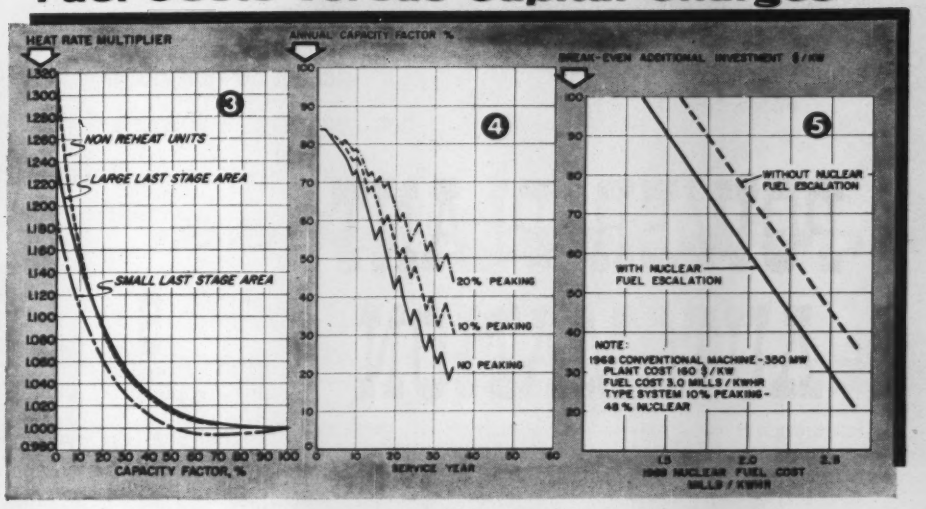

Fig. 3 The curve obtained in Fig. 2 is combined with the heat-rate-versus-load-curve (or test curve if available) supplied by the turbine manufacturer. This curve, in which the co-ordinates are machine capacity factor versus heat-rate correction, is stored in the computer. With this correction, the average annual operating heat rate of the machine is obtained.

Fig. 4 The addition of peaking capacity results in a substantial increase in annual capacity factor for the proposed high-efficiency machines and ultimately could lead to justifying further advances in steam conditions

Fig. 5 The justified additional investment for a nuclear power plant with various first-year nuclear-fuel costs was calculated with and without nuclear-fuel escalation while fossil-fuel cost was escalated

of study has been conducted in the past; however, the use of the computer makes it possible to study many alternative installation plans in a short period of time.

In addition to these generation-planning studies the program is used for all types of studies which require an analysis of fuel and fixed-charge costs. The program has been applied to the following problems and work is continuing on refining the study technique so that others may be included: (*a*) Turbine-generator selection technique, (*b*) system fuel-requirement projections, (*c*) nuclear-power-plant justification studies, (*d*) economy studies requiring a knowledge of machine capacities.

Turbine-Generator Selection Technique. The unit-selection technique involves two phases. The first is a general study which uses as a program background the 35-year optimum system information or uses various backgrounds to interpret the effect of potential future changes from the selected optimum. The generalized study uses price-book information to reduce to a minimum the machine types and throttle conditions for which bids will be taken. This also is used to determine the amount which can be paid for each Btu per kwhr improvement in heat rate for different design-heat-rate machines. The second phases of such a study involves plugging into the program the turbine heat rate and heat-rate correction information submitted by each bidder. The optimum bid is evaluated by analyzing the difference in level annual system fuel costs which result from installing the various bid machines and comparing the capitalized differences to the bid price differences.

Fuel-Consumption Projections. The program print-out data sheets provide an immediate resource for those requiring a knowledge of short and long-range fuel consumption. Depending on the program selected, the minimum and maximum future fuel consumption is obtained. This planning information is required by operating and purchasing personnel.

Nuclear-Power-Plant Justification Studies. The comparison of nuclear and conventional power plants is a complex problem with many variable conditions which must be studied. The generation-planning program has been useful in studying the effect of varying fossil and nuclear base fuel costs and fuel-cost escalations, load growths, and load factors. A typical result of such a study is shown in Fig. 5. This curve shows the justified investment difference which can be paid for a nuclear power plant with various first-year nuclear fuel costs. The flexibility of the program is indicated by the fact that the justified investment difference was calculated with and without nuclear-fuel escalation while fossil fuel was escalated. It was also established in this particular study that 48 per cent of the generation installed after the first nuclear plant would be nuclear generation and 10 per cent would be peaking capacity.

Power-Plant Component Studies. Studies such as boiler-feed-pump drive selection, number of feedwater heaters, and make-up evaporator output all require a knowledge of future machine loading. With this program it is possible to gain an accurate estimate of the fuel savings or penalty afforded by the various alternatives.

Conclusion

The Detroit Edison Company has developed a computer-type program which is an essential tool. It is used daily to provide short-range and long-range system plans and side results which serve as a basis for making various comparative studies required in power-plant design. The answers are provided at a reasonable cost within a reasonable time as a result of the averaging technique described in this paper.

The important value attached to this program by The Detroit Edison Company is that engineering recommendations can be made to company management based on a thorough analysis of the variable factors involved. Management can also be readily appraised of the minimum and maximum financial return which will result from their decision.

Acknowledgment

The authors wish to express their appreciation to W. W. Brown for the direction he offered in developing the basic program; and to E. M. Benson, L. W. Coombe, D. E. Hart, W. J. Pfeifer, Jr., and R. O. Underwood, all of The Detroit Edison Company, for their diligent efforts in developing the program procedure used for this method of analysis and in compiling the basic data.

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POWER PLANT AUTOMATION

Since the application of computer monitoring and computer control of boilers is in its infancy, the initial applications should be based on the concept that the computer merely substitutes a properly sequenced program for the functions previously performed by human operators, Figs. 1 and 2. These include the monitoring of a multitude of conditions—such as temperatures, pressures, flows, fluid levels, the combustion process, damper and valve positions, and the operation of auxiliaries—and correlating them to determine the action necessary, through the medium of conventional automatic controls, to obtain the conditions desired.

Among the major benefits of automation, Fig. 3, is the fact that it can prevent furnace explosions or other casualties by either correcting the conditions or by tripping out pieces of equipment. It can reduce the number of outages by taking prompt corrective actions and by stopping the chain sequences so often encountered. Less maintenance is required because of better control of temperatures and pressures to minimize overstressing and overheating, and reduce the possibility of pressure-part failures. Average unit efficiency is improved by more precise monitoring of the actual boiler operating conditions and the heat-rate data on which unit loading is based. Fewer operating personnel are required although in the initial stages more and higher-caliber manpower may be needed.

Against these benefits must be weighed the disadvantages, Fig. 4. Complexity is foremost. The computer and its tie-in to the controls add a most intricate assemblage of equipment and electrical circuitry to the

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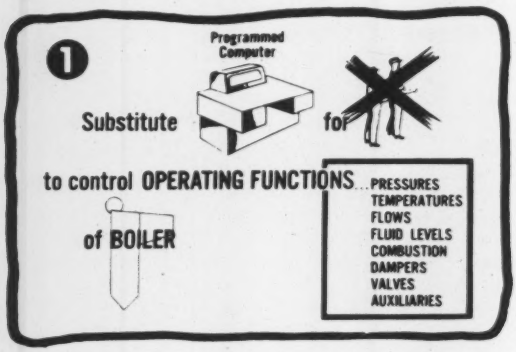


Conventional controls may disappear, the computer — properly programmed and equipped — taking over control functions in

AUTOMATION

-Boiler Operation

By G. W. Kessler, Mem. ASME, Chief Engineer, The Babcock & Wilcox Company, Barberton, Ohio.

power plant. Computer maintenance is imperative and must be conducted on a regularly prescribed schedule if high availability is to be attained. Since the computer is an integral part of the control and operating system, it must have high reliability and this has not, as yet, been proved. Any outage of the computer will shut down the boiler unless operation by station personnel during computer outages has been prearranged. The computer is an expensive item, and the costs of engineering the system are appreciable.

Computer Programming

The computer operates with three basic actions that are performed over and over and over. It reads or scans conditions and references. It takes the actions required by these conditions or references. It indicates alarm when it cannot carry out the required program.

A step-by-step sequence, Fig. 5, must be worked out describing every detail of the job to be done. Any errors, extra steps, or omissions will be carried out or left out just as faithfully as they have been included or left out by the programmers. These details are translated into diagrams known as flow charts. By assigning numbers to, and by cataloging every switch position, temperature, pressure, contact closure, or other condition that will be scanned or stored in the computer's memory, the proper reference number for each action can be listed on the flow charts.

It is mandatory, when flow charting, to provide sequences that can be stopped safely at any point without harm to the equipment; or to program operations so that they cannot stop until they have reached a point where operation is safe. This is necessary in order to handle those situations wherein a boiler operator may push a stop button in the middle of some action which could not be safely stopped at that point.

Due to the interrelation of the boiler, turbine, and auxiliaries, the boiler, turbine, and auxiliary-equipment-manufacturers, the consulting engineers, and the customer must all work together to properly integrate all operations where the performance of the equipment is interdependent. In the past a note could be put on a drawing stating that "our work stops here," but this is no longer possible. The responsibility of the boiler manufacturer is broadened, Fig. 6, to tie in with the operations of the feed pump, the blowdown and valving systems, the turbine, and such normal auxiliaries as the soot blowers and the fuel systems.

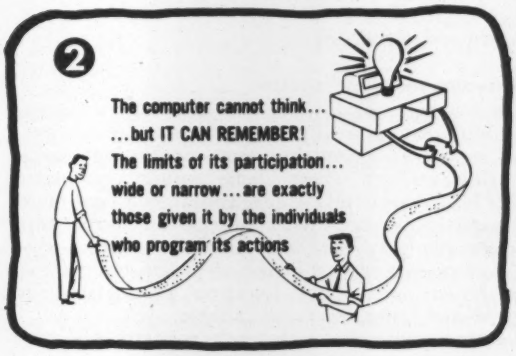
One of the boiler manufacturer's important responsibilities in connection with complete boiler automation is to provide programming, or flow charting assistance, and information to properly co-ordinate interrelated operations.

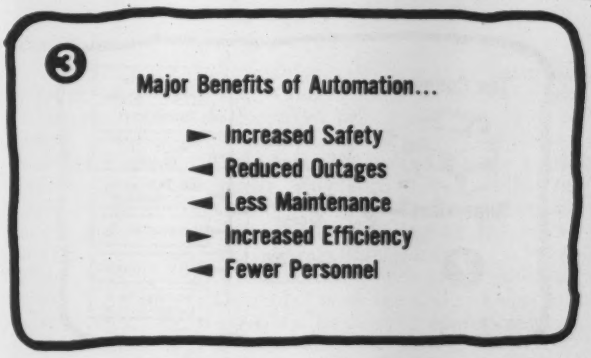
Methods of Automation

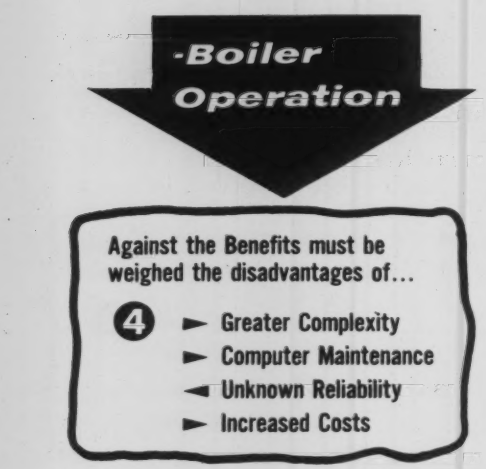
There are several approaches by which computers may be applied to power-plant operation. One approach is that taken by the Southern California Edison Company for units 3 and 4 at Huntington Beach. In this arrangement, the computer supervises the control of functional groups, or subloops, Fig. 7.

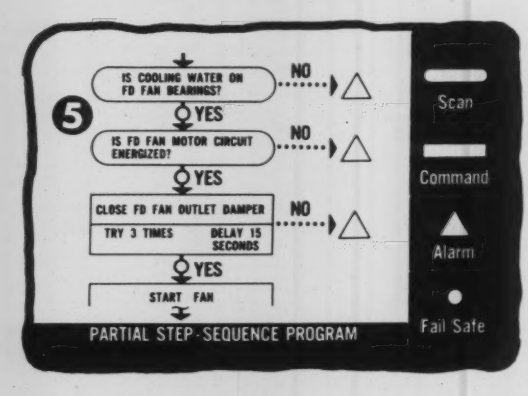
During start-up and shutdown periods the computer controls operation through the subloops, following the step-by-step sequence programmed. At appropriate points in the sequence, the computer releases the subloops to their own automatic operation or takes over operation from the subloops. In addition, the computer prints out the operating data for record purposes and also calculates the heat rate based upon the actual data.

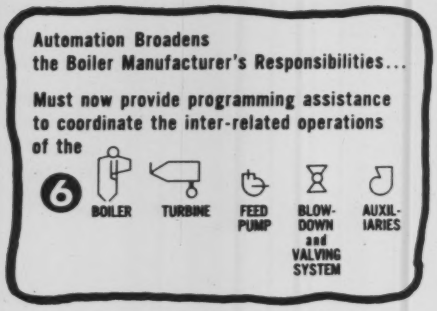
The application of computer monitoring and supervision to boiler operation has not created any insurmountable problems when conventional subloop controls

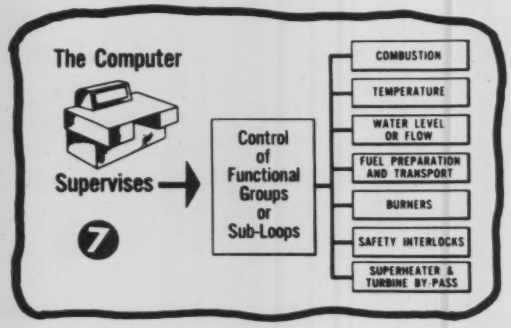

2
The computer cannot think...
...but IT CAN REMEMBER!
The limits of its participation...
wide or narrow...are exactly
those given it by the individuals
who program its actions

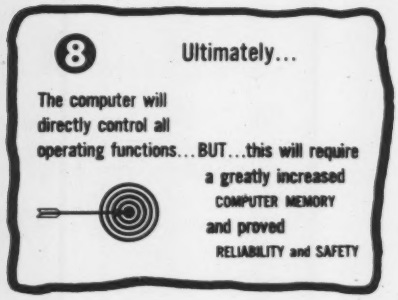












are used. Engineering ingenuity and time are required to apply operating drives to the valves and systems which are normally manually operated, but such mechanisms are available. However, a tremendous amount of engineering time and know-how is required to establish the type and the location of all of the sensing devices required to provide the computer with the necessary information so that it can safely supervise and control the operation of the boiler through normal start-ups, normal operation (including load swings), normal shutdowns, emergency shutdowns or trip-outs, and hot restarts. Even more engineering talent is required to sequence the operations and to determine the safety interlocks and trip-out information required for all of the foreseeable conditions which could possibly occur. All eventualities, however remote, must be programmed into the computer so that it will take the correct action; and failure to consider any possibility could result in a casualty to the unit.

Ultimately, the functions of the subloop controls probably will be taken over entirely by the computer. To do this, its memory and reference or address-system capacity will have to be greatly increased since the number of computer programs required will be multiplied many times, Fig. 8. An approach in this general direction is being engineered by one of the large utilities.

In that application, the computer will not only monitor the operations of the subloops during normal automatic operation, but will actually go into the three major subloops—the boiler-turbine-generator control system, the burner control system, and the steam-temperature control system—and optimize the controls to effect the best possible unit efficiency under changing conditions. The application also will utilize direct operation in some areas without the use of subloops.

In the present state of automation, the author's company believes that it is desirable to employ the full use of subloop controls, most of which have been developed to a high degree of reliability and safety when properly maintained and supervised.

Flame Detection and Burner Control

The most significant advance that has permitted automation of oil and gas-fired utility boilers is the development of sensitive, dependable flame-monitoring equipment. However, the best flame-sensing equipment available is still relatively crude, and a great deal more research and development work must be done before this will be absolutely safe and will eliminate nuisance trip-outs. Automation of coal-fired boilers will lag gas and oil-fired boilers until flame detection, particularly for pulverized-coal firing, is proved reliable.

The author's company is presently engaged in a joint

research program with the Bailey Meter Company to design and develop a completely automatic burner control for oil and gas. Part of the development consists of a new flame detector—sensitive to ultraviolet light—which has promise of greatly surpassing those now available. Tests have shown that it is satisfactory for the detection of either oil or gas flames with relatively uniform sensitivity.

Weak Links in Automation

Although complete automatic burner control is the prime essential for boiler automation, equipment also is important and essential. Some of this equipment, even the best that is commercially available, may be weak links in the chain of automation.

In particular, the equipment which must be made more accurate, sensitive, and reliable includes the items shown in Fig. 9. Pressure switches must have a wider range, repeatability, little or no hysteresis, and very accurate set points. Electrical equipment requiring contactors or relays has not been satisfactory, with the result that transistorized circuits are being used in every possible circuit of the latest controls. Solenoid valves are definitely weak points in the system and should be eliminated in every possible application. They limit the use of pneumatic controls in the subloops, and subloops of the future will undoubtedly be electrically controlled. Gas-analyzing-equipment maintenance must be reduced and the time lag between sampling and the indicating of results must be decreased. Flow-measuring equipment falls far short of requirements and probably needs wholly new techniques. With truly accurate flow measurement, input-output efficiencies could be determined; pressure-part failures could be detected; and cross checks on fuel-air ratios and gas analyses would permit operation at the highest possible efficiencies. Representative sampling is important in today's power-plant operation and will be even more important in computer automation.

Unless the techniques can be improved, the potential economies they can provide will never be realized. Instruments, undesigned as yet, which probably will become a part of future automation would provide automatic analyses of feedwater, ultimate analyses of fuel, and calorific heat contents of coal and oil.

Boilers Designed for Automation

No boiler manufacturer has, as yet, designed a utility boiler with "ease of automation" as the main design objective. Instead, automation has been applied to boilers already designed or in operation. However, the design innovations already developed which facilitate automation include: (*a*) Forced-flow, once-through boilers—which offer ease of steam-temperature control, pressure control, cold start-up, hot restart and shutdown, and require no water-level controls; (*b*) drainable-type superheaters—which facilitate start up; (*c*) pressure firing—which eliminates the need for two sets of fans and the requirements for balancing draft; (*d*) tempering, either air or gas—which can be used to control the gas temperature entering the superheater during start-up and shutdown operations.

Simulation of Boiler Operation

In order to co-ordinate all of the functions required by the over-all control system which will eventually take over the tasks of subloop controls, it is desirable to simulate the complete boiler-turbine cycle on a computer. This enables the control-systems' engineer to determine the characteristics of all of the components, the effects of changes in one part of the cycle upon other parts, and the relative importance and effectiveness of various control features and equipment designs. In essence, this simulation would provide a description of cycle operations which has never before been available, Fig. 10. The author's company and the Bailey Meter Company are currently engaged in such a simulation of the cycle operations for Huntington Beach units 3 and 4.

Useful data have been collected by another method. During 1955, the two companies jointly developed Datak—an assemblage of automatic data-gathering equipment (Mechanical Engineering, November, 1957, pp. 1016–1021). Later, in 1956, this system was installed on a boiler at Springdale and teletype communication established with a computer in New York. Test data, taken at Springdale, were transmitted to New York, fed to the computer, and the results received back at Springdale in less than an hour's time from the start of the test. No attempt was made to automatically control operations.

Conclusions

The scope of future boiler automation is easier to predict than achieve. Conventional controls could disappear with their functions taken over by the computer, acting directly on the control drives. Accurate heat rates would then be available on the basis of actual performance. Combining this information with instantaneous calculation of line loads and losses would make possible true incremental loading of the units. Boiler explosions and catastrophic damage could be virtually eliminated by complete knowledge of all boiler operating conditions, coupled with the ability to correct upset conditions, if possible, or to take appropriate action to shut down the boiler safely.

AUTOMATION

The operational logic used for computer programming, and the subloop controls applied for

-Turbine Generators

By **E. G. Noyes**[1], Assoc. Mem. ASME, **and J. D. Davidson**[2], Westinghouse Electric Corporation, Lester, Pa.

COMPLETE steam-plant automation requires a control system with the ability to sense hundreds of conditions and to adjust many devices in maintaining the proper level of all plant-controlled variables.

Today, the extent of the digital-computer application is not clearly defined. Some contend all control functions should be performed by the computer, whereas others feel the application of subcontrol loops, with computer-adjusted set points, should be extended. It is certain that philosophy will change as operating experience is obtained and new ideas materialize. However, at present there has been little desire to eliminate any of the established closed-loop control systems on the basis that the digital computer should perform these functions. Rather, the use of subcontrol loops is being extended.

In either approach, the computer has a vast potential within the limitation of the available memory. It is apparent that the automatic steam plant will not be limited by the computer but rather by man's ability to plan and program for all possible contingencies.

The automation design philosophy for turbine-generator units should be based primarily on safety and operating reliability (example of starting logic, Fig. 1).

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Condensed from a paper contributed by the Power Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS and presented at the ASME-AIEE Power Conference, Philadephia, Pa., September 21–23, 1960.

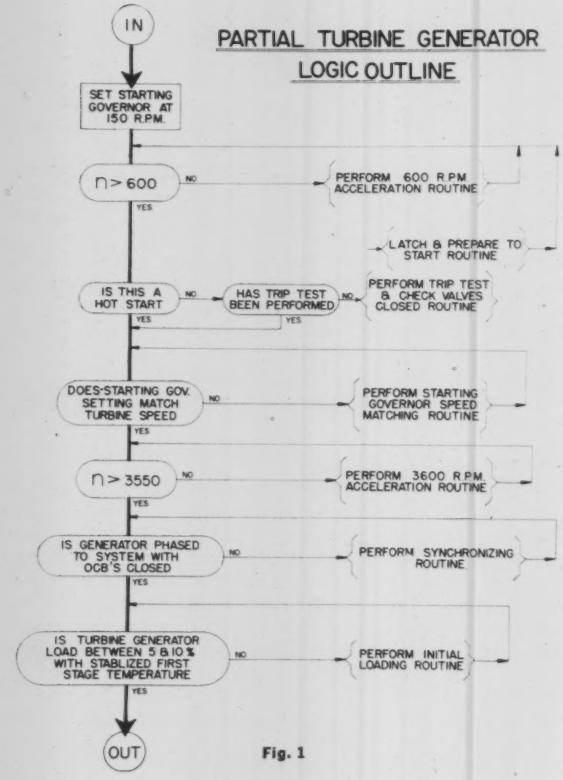


Fig. 1

Turbine Considerations

There are a number of variables the computer must monitor when supervising the control of the turbine-generator unit during transient speed and load operation. These conditions are based on past operating experience and design criteria. The critical nature of these conditions has been recognized, and many units installed in the past ten years have the necessary instrumentation to give the operator a record of these variables (Fig. 2).

Turbine temperature condition generally is considered one of the most important. Extreme values of eccentricity, vibration, and differential expansion are usually the result of an abnormal temperature distribution. Severe temperature transients can result in conditions which may be anticipated and controlled. These are:

High thermal stress of thick wall stationary parts which may cause temporary or permanent distortion.

Excessive differential expansion which may produce a rub and result in rotor vibration.

Abnormal radial and axial temperature gradient in the turbine rotor causing an additional rotor stress.

The basic instrumentation and the limits established are selected to anticipate these conditions. The following requirements represent the minimum:

Prior to admitting steam to the unit, the superheater outlet temperature is to be controlled at a value depending on the throttle-stop valve inner wall and turbine first-stage metal temperature.

During starting, the steam flow rate is to be controlled to limit the temperature gradient across the throttle valve, steam chest, and casing walls.

To avoid condensation, prior to transferring to normal governor control, the temperatures of the steam-swept surfaces of the inlet features are to be at a temperature higher than the saturation temperature which these parts will be subjected to during subsequent partial admission operation.

Considering that the first stage temperature will increase approximately 250 F from no load to full load (assuming constant inlet temperature), the rate of change of this temperature must be considered.

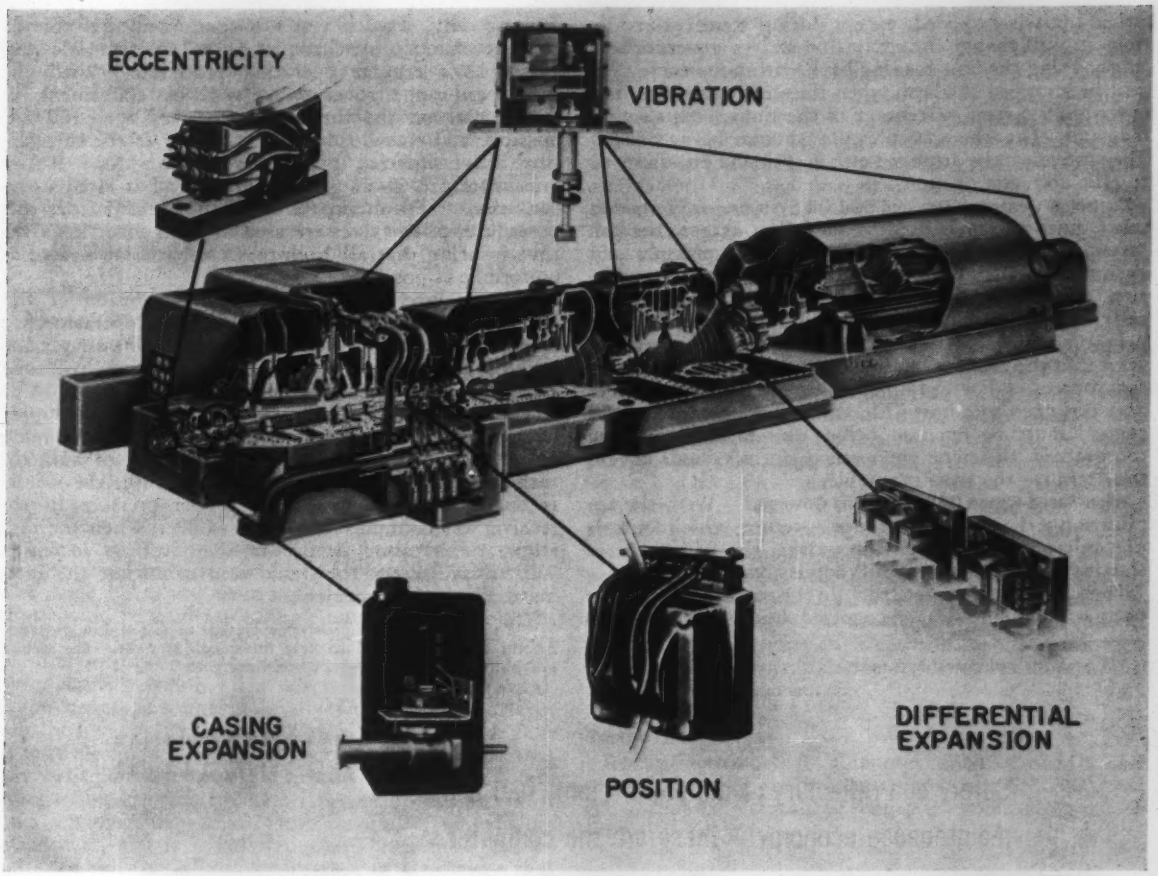


Fig. 2 A number of variables must be monitored by the computer when supervising the turbine-generator unit: (a) Rotor eccentricity and vibration, (b) rotor-casing differential expansion, (c) rotor position, and (d) cylinder expansion. Extreme values of eccentricity vibration, and differential expansion are usually the result of an abnormal temperature distribution.

Generator Considerations

When the generator features required for an automated plant are examined, it is found that the generator itself is not materially different from one built for normal control. However, some of the auxiliary equipment associated with the unit will be changed to make it suitable for automatic control. The present practice, in a large number of utilities, is to record the average rotor temperature as well as the readings of a selected number of the stator winding RTD's (Resistance Temperature Detectors).

The hot and cold gas temperature may or may not be recorded. On automated units, with the generator loading supervised by the capability-curve limiter, and with the generator cold gas being maintained by a subcontrol loop, recording the rotor and stator temperatures does not appear to be necessary. It would seem that it would be more desirable to have the computer periodically compute the rotor and stator temperature rises, and compare these values to those expected for the particular gas pressure within the machine.

On cross-compound units, the normal practice is to synchronize the two shafts at turning gear speed. However, if the starting procedure is held at a relatively low speed; for some reason such as eccentricity, the generator-rotor temperatures can be the limiting factor as to the time the unit can be held at reduced speeds. This is because the generator ventilation system may not circulate enough gas to cool the rotors even though the excitation is considerably below the rated value.

Subcontrol Loops

A number of normal functions can be under the control of self-contained subloops. These loops can be monitored by the computer. In some cases, the computer will alter the set-points depending on conditions existing in the unit.

Vibration and Differential Expansion Trips. The vibration and differentiational expansion trips employ simple circuits completely independent of the recording and control instrumentation. Separately guarded pickups utilizing electromagnetic or static circuitry are used to insure reliability. If the rotor motion exceeds a predetermined limit, a device actuates the turbine trip circuit.

Generator Capability Curve Limiter. Such a device has three input variables: Generator kw, kvar, and hydrogen pressure. There are two outputs—one to the generator voltage regulator and one to the turbine speed-changer motor. For a given hydrogen pressure, this device compares the kw and reactive loading to that allowed. If

either limit is exceeded, except during transient conditions, it will change the excitation and/or governor setting to bring the unit loading back within the curve. It will be arranged to alarm when the steady-state loading is within a certain percentage of the limit. This signal indicates that the gas pressure should be increased. The system can be arranged either to sound an alarm or to take corrective action.

Control of Generator Gas and Seal Oil Systems. In a station where automation is used to its fullest extent, the gas system is designed to maintain hydrogen pressure and purity by means of another subcontrol loop. In addition, the generator may be filled with hydrogen automatically, the sequence being initiated by the computer.

In some cases, it will be necessary to repair a particular device, in the event it malfunctions, before the operation can proceed. For example, if a power-operated valve does not open to admit CO_2, this valve or its associated control must be repaired before the filling operation can proceed. The computer can perform various checks to determine the specific trouble.

Wide-Speed-Range DACA[3] Starting Governor. With the application of the wide-speed-range governor, which controls the unit on the throttle-stop valves, the advantage of starting the turbine with full admission of the governor valves can be easily extended. In the past, the advantage of this procedure was recognized but was limited to starting only, since it was not considered advisable to attempt manual synchronizing on the throttle-stop valves as a regular operating procedure. With the wide-speed-range governor it will be convenient to synchronize on the throttle-stop valves with full admission, and then load to the capacity of the throttle-stop valve internal pilot valves. This load is approximately 20 to 25 per cent rated load at rated steam conditions. To obtain the maximum benefit from this procedure, pilot valves are used in both throttle valves thus insuring that all high-pressure parts are heated as uniformly as possible.

Automatic Rotor Turning Gear.[4] The extension of the remote-operated turning gear to automatic operation was dependent on the successful development of a simple and reliable means of indicating zero speed. A hydraulic zero-speed device has been developed which produces an elevated pressure when rotation stops. Two oil-supply nozzles discharge to two receivers through circumferential holes drilled in a disk-mounted integral with the turbine rotor. When the disk is rotating, the oil jet is continuously interrupted and the pressure in the receiver is maintained at a low value. When the disk stops, the pressure in one of the receivers increases. This oil pressure is the signal used to initiate the automatic turning-gear control.

[3] Digital Analog Control Apparatus.

[4] "Turning gear" continuously revolves the spindle at slow speed during the shutdown period to keep the spindle straight. The turning gear automatically disengages when starting up.

AUTOMATION

Safety and reliability of the power plant, fuel and maintenance economy — these are the computer's

-Economic Justification

By W. T. Hess, Vice-President and Chief Engineer, Louisiana Power & Light Company, New Orleans, La.

DURING the early stages of designing Unit No. 1 for the Little Gypsy Station of Louisiana Power & Light Company it was decided to use a computer that would be adequate for the control of automatic operation for the plant. The estimated cost for providing computer control of a unit similar to the Sterlington Unit No. 6 was $630,000. This is a Daystrom solid-state digital computer with a guarantee of 99 per cent availability which monitors essential temperatures and pressures, records the data thought necessary for historical purposes, and makes computations of over-all thermal efficiency.

The economic justification for this expenditure is still uncertain, but it is felt that a potential exists for the improvement of safety to manpower and equipment, the improvement of fuel economy, the reduction of manpower required for operation, and the reduction of maintenance because of closer adherence to temperature and pressure limitations.

Portions of a paper contributed by the Power Division and presented at the National Power Conference, Philadelphia, Pa., September 21–23, 1960, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS and the American Institute of Electrical Engineers. Originally entitled "The Organization and Management of Automated Power Plants."

Improvement of Safety

The improvement in safety to the equipment offers the greatest potential saving, yet is the most difficult to substantiate except on the basis of probabilities. Statistics studied indicate a probability of about one third for a major, serious accident during the service life of a generating unit. With units of the size being considered, the cost of such serious accidents has run as high as $4 million, not including the cost of replacement energy during the outage time. Thus the elimination of this possibility alone can justify the computer control. Of course, each company always feels that it can't happen to them, but the statistics say it can.

If a computer is properly programmed for start-up, operation, and shutdown these operations will always be carried on in a safe manner. The computer will always perform the same operation when supplied with identical indications of the state of the unit. It will never panic, it will not forget, and it will not reach for the wrong control. Of course, the successful programming depends upon human beings and is therefore subject to human error the same as an operator. However, the programming is the consensus of the best thinking available from engineers, operators, and computer specialists,

and that thinking is constantly available from the computer at all times during all phases of operations. The computer control is equivalent to having instantly available the supervision of the best known experts in every field and should certainly result in safer operation. Some operators do not consider the improvement of safety a justification for the expenditure of any capital because damage done is covered by insurance. However, in the long run the cost of damages must be paid for in the insurance premiums, and the elimination of hazards should result in a decrease of these costs.

Improvement in Fuel Economy

The improvement in fuel economy is something that will be ascertainable by trial runs with computer control and without it. There is no way of determining what, if any, gain can be obtained until it has been tried. However, a saving of 0.5 per cent in fuel consumption for a unit this size will justify the expenditure of from $125,000 to $175,000. It does not stretch the imagination too far to assume that a fuel saving of that magnitude is possible.

Reduction of Manpower

There will be no reduction of manpower in the operating personnel provided for Little Gypsy No. 1 initially. The same operating force will be in attendance there that would be used for a single-unit plant without the computer control. There will be an operating force of three men per shift each working 40 hours per week on a shift schedule. The electrical and mechanical-maintenance personnel normally work eight hours per day for five days per week. This is being done to make it possible to operate this unit in the same manner that any other unit would be operated, in order to obtain comparison between the two types of operation. This does not mean that there is no possibility of reducing manpower, and it is believed that future units can be installed without the same increase in manpower that would be experienced without computer control. There is considerable potential saving here because the elimination of one shift position will justify the investment of about $250,000.

There should be some saving in routine maintenance because of closer control over temperature and pressure tolerances. The capitalized value of such savings might amount to $50,000 or $100,000.

At Little Gypsy, full advantage has not been taken of the computer possibilities for control in that the computer has been superimposed upon the automatic controls that would be used normally—such as combustion control, feedwater control, and so forth. It is possible, in the author's opinion, to dispense with other controls (where economical) and turn the entire job over to the computer. The chairman of the Board, however, said, "Let's fix this one up so that we can operate it just as we would any other unit if we decide that we don't like computers." Little Gypsy No. 1 can be operated exactly as other company units without the computer. The computer can, however, when it is in operation, reach through these controls to optimize the operation or to take over for safe control just as an operator could in the event of malfunction of any controls.

Design Requirements

The "ground rules" that were set up for the design and programming of the Little Gypsy installation were extremely strict. They were: (*a*) Automation is to be designed on the assumption that the plant is unattended; (*b*) the computer must, therefore, be able to do whatever the operators do at the present; (*c*) in the event of failure or malfunction of any equipment involving safety to personnel or plant, the computer must be able to take corrective action or shut down the unit (initially, alarms will be used instead of shutdown where time element allows); (*d*) in the event of such failure or malfunction involving economy only, the computer may alarm only and tag out for maintenance—this then becomes a problem of simple economics, balancing the cost of automation against the estimated cost of loss in economy.

These ground rules forced the automation of a number of valves that are infrequently operated. This could be dispensed with if the assumption were made that an operator would always be available. However, it was very noticeable during the discussions early in the design period that there was a tendency toward sending the "man" to do a great many things instead of automating the function. With the feeling that the first steam-electric generating station capable of completely automatic operation should be capable of actually completely automatic operation, the ground rules were written as they were. It is not at all unlikely, and perhaps probable, that experience at this station will recommend the elimination of some of these controls on the assumption that a man will be available to perform certain operations indicated by the computer.

Summary

The estimated cost for computer control above the cost of a monitoring and results computer is $630,000, and the estimated capitalized value of potential gains is shown in Table 1.

Table 1 Estimated Capitalized Value of Potential Gains

	Probable maximum
Reduction of major mishaps	$1,500,000
Increased fuel economy	175,000
Reduction of manpower	500,000
Reduction of maintenance	100,000
	$2,275,000

An attractive possible application of computer control in the future is for the complete control of generating units installed for peaking or emergency service. Such units would operate on a simpler cycle, because fuel economy would not be important, and would be simpler to automate. They would be inoperative most of the time, being needed only for a comparatively few hours for peaking service or during outage of other equipment. The elimination of manpower for their operation would not only result in economy but would also eliminate a bothersome personnel problem.

The signal to start up and shut down could come from the Economic Dispatch Computer, which is located in the system dispatcher's office at the Middle South System control center at Pine Bluff, Ark.—about 450 miles away.

Finally, the computer has proved to be the most reliable piece of equipment in the Sterlington Station. At Little Gypsy, it should improve the safety and reliability of the plant operations and result in fuel and maintenance economy. Additional advantages of its use should be uncovered through operating experience.

1970 POWER REACTORS -The Next Ten Years

By Frank K. Pittman[1] and Ulysses M. Staebler[2]
U. S. Atomic Energy Commission, Germantown, Md.

Evaluation of nuclear power methods is not a one-shot effort, but a continuing study. Conclusions are subject to revision as engineers break through—or are blocked—in their lines of attack.

1960

LONG-RANGE plans for the Civilian Power Reactor Program have been based on a study utilizing the talents, knowledge, judgment, and know-how of persons within the Atomic Energy Commission and its laboratories, and from the nuclear industry throughout the United States.

Program Objectives

Most of the plans for the development of civilian power by large central-station plants hinge on the reduction of the cost of nuclear power—first, to levels competitive with power from fossil fuels in high energy-cost areas of this country by 1968; and, over a longer period, to competitive levels over wider areas.

To provide uniform comparisons, differences of opinion and geographical variations were ignored. High-energy-cost areas were considered to be those where fossil fuels cost 35 cents or more per million Btu. Conventional power generation in these areas was estimated to cost about 7 mills per kwhr for a 300-emw single-unit fossil-fuel station operating at an 80 per cent load factor with 14 per cent fixed-charge rate on an estimated capital cost of $166 per net ekw.

By 1968 it will be possible to achieve economic nuclear power in high-cost areas of the United States with continued aggressive development of light-water-cooled and organic-cooled reactors, although the selection of one to the exclusion of the other does not appear justified.

In the water systems, difficulties may arise in developing a suitable and economical fuel element capable of operating at the higher temperature and more severe conditions required to make superheated steam. Other projected technical improvements may or may not materialize into economic improvements or may take longer to achieve than now estimated.

In the organic systems the principal uncertainty is the development of a fuel element simultaneously capable of long exposure and of reasonably high rates of heat transfer into an organic coolant.

Despite these uncertainties, the number of potential areas of improvement still unexplored warrant the assumption that one or both systems will also be serious contenders in the long-range power picture.

The first systems to achieve economically competitive nuclear power will be the standards by which other systems are judged. The greater experience behind the water and organic systems and the probability that increasing use will lead to simplifications, standardizations, and the economies of volume production will be distinct advantages. These must be offset by special features if other systems are to warrant similar development efforts. Nevertheless, other systems do have advantages which, at least at the present time, warrant extensive research and development effort.

There is a possibility that the liquid-metal and gas-cooled systems could meet the short-range goals, but the AEC program places major emphasis on these systems in its longer-range program. Present knowledge indicates that liquid-metal-cooled systems, with their high steam-cycle efficiencies, have excellent economic potential, but because of the technical difficulties that must be solved, the economic potential will take longer to realize and its achievement may be more costly than that of the hydrogenous systems.

Although performance data are lacking on gas-cooled systems, the currently estimated potential appears attractive, due largely to the high thermal efficiency offered by this system. An aggressive research and development effort will be pursued so that a realistic comparative evaluation of this reactor system can be made at the earliest practical date.

The part to be played by heavy-water-moderated natural-uranium-fueled reactors in either the short or long range is uncertain and sensitive to such factors as methods of financing and terms of availability of fuel material and heavy water. However, the advantages of a natural-uranium-fueled reactor are apparent. It eliminates dependence upon diffusion plants in the fuel cycle, it has high neutron economy, and it requires relatively small quantities of uranium ore per unit of power produced. Research and development will be directed toward those problems which are most critical to the evaluation of heavy-water-moderated systems and will use to the fullest extent possible pertinent information being developed in other countries.

[1] Director, Division of Reactor Development
[2] Senior Assistant Director, Division of Reactor Development.

Based on Paper 17 presented at the 1960 Nuclear Congress, New York, N. Y., April 4–7, 1960, co-ordinated by the Engineers Joint Council.

Water Reactors

AEC-supported research and development of water reactors over the next four or five years will be aimed primarily at obtaining solution to the problems of nuclear superheat, increased fuel life, simplified less expensive fabrication techniques, fuel-management techniques, simplified and less costly containment methods, and cheaper materials and methods of construction. A major effort also will be made to develop techniques for utilizing plutonium economically as a fuel material in water-moderated and cooled reactors.

Pressurized-Water Systems. The Shippingport Atomic Power Station will be modified to raise its gross electrical power from 68 to 150 emw equivalent. A heat sink will be constructed for power dissipation beyond the 100-emw capacity of the turbine-generator facilities. This will not reduce the technical benefits to be achieved. The plant will continue to be operated to demonstrate the life potential of the present rod-type zircalloy-clad, uranium-oxide blanket elements with a second, and perhaps a third, longer-life seed of fully enriched uranium. The present core will then be replaced by the newly developed higher-power-density, compartmented flat-plate uranium-oxide seed-and-blanket core. Other plant modifications will also be made.

The schedule and design characteristics of future pressurized-water prototype plants will depend to a great extent upon the research and development from the Shippingport, Yankee, and Indian Point stations. Among the important new features to be tested in the Yankee plant are stainless-steel clad, slightly enriched uranium-dioxide fuel elements, and solution poison for shutdown control. Indian Point will provide important operating data for large water-cooled reactor systems and technical data on the use of fuel mixtures of thorium and U-235.

Additional pressurized-water technology will result from the small experimental reactor of the Saxton Nuclear Experimental Corporation on which construction started at Saxton, Pa., in February, 1960, and other projects currently in the planning stage.

At least one additional pressurized-water prototype will probably be justified by the results from the projects already mentioned. Design could begin in 1962 or 1963.

If the development work initiated this year on the spectral-shift variation of pressurized-water systems is successful, and the concept still appears promsing, initiation of construction of a 50 to 100-emw prototype may be justified in the early 1960's.

Boiling-Water Systems. Most of the currently foreseen developments in boiling-water technology probably will be demonstrated with the many reactors of this type currently in operation, being built, or authorized. Much experience has already been gained from operation of the BORAX series, the Experimental Boiling Water Reactor, and the Vallecitos Boiling Water Reactor. All three have been modified or are being reconstructed to advance the technology of this concept.

A family of new small and large-scale prototype reactors extends from the Elk River reactor, which will produce 16 mw of electricity plus 6 mw from conventional superheat, to the 180-emw Dresden Nuclear Power Station, the largest all-nuclear plant in the country. Between these large and small reactors are several intermediate-size boiling reactors which should be completed in the next two to three years: (*a*) The Humboldt Bay Project of the Pacific Gas & Electric Company in northern California; (*b*) the 50 to 75-emw high-power-density boiling-water reactor of the Consumers Power Company in Michigan; and (*c*) a 50-emw Improved Cycle Boiling Water Reactor.

When operating experience is available from all of these reactors, in 1963 or 1964, it will be possible to determine what, if any, additional experimental or prototype reactors are needed to achieve competitive nuclear power in large reactors. Until such a determination is made, no further construction of large boiling-water experimental or prototype reactors is contemplated by the AEC.

Nuclear Superheat. Nuclear superheat, which can be applied to both direct and indirect-cycle boiling-water reactors and to indirect-cycle pressurized-water reactors, will be demonstrated experimentally in the fifth BORAX project, now under construction in Idaho; in the Pathfinder Atomic Power Plant under construction near Sioux Falls, S. D.; and in the Boiling Nuclear Superheat, BONUS, project which will be built in Puerto Rico.

If the technical and economic information obtained confirms the prediction that nuclear superheat can substantially lower power costs, a 100-emw prototype probably would be initiated in 1963. If successful, utilities in certain areas of the country could construct a large economically attractive plant incorporating integral nuclear superheat by 1968.

Organic-Cooled Reactors

Organic-cooled[3] reactors have achieved a prominent place in the Civilian Power Program although only one small reactor of this type, the OMRE, has been operated. Because of the successful operation of this reactor, the inherent simplicity of the system, and the direct applicability of much of the water-reactor technology to the organic-cooled system, it is believed that this concept can achieve its early potential with a smaller research, development, and construction effort than that required for other reactor concepts. The development of a long-life fuel element with satisfactory heat-transfer characteristics is the principal immediate problem. Of longer range importance is the problem of decreasing the cost resulting from decomposition of the organic coolant under reactor operating conditions.

As a supplement to OMRE, a more flexible 40-tmw Experimental Organic Cooled Reactor will be built at the National Reactor Testing Station in Idaho.

The 11-emw organic-cooled and moderated reactor being built for the City of Piqua, Ohio, scheduled for criticality in 1961, will also provide important operational data that can be extrapolated to large organic-cooled and moderated plants, even though it is of primary importance as a prototype for small nuclear power plants.

A 50 to 100-emw Prototype Organic Cooled Reactor has been authorized to provide data on use of an improved fuel such as aluminum-cermet-clad uranium dioxide. This is primarily a prototype for future large-scale power reactors, but the basic fuel-element information would also be important for process-heat and small power-reactor systems.

[3] Organic compounds consisting largely (or entirely) of carbon and hydrogen. A possible example might be the eutectic mixture of diphenyl and diphenylene oxide called Dowtherm A, used as a heat-transfer agent in industry. From "Principles of Nuclear Reactor Engineering," by Samuel Glasstone, published by D. Van Nostrand, Inc.

POWER REACTORS
-The Next Ten Years

By the middle 1960's, a 50 to 100-emw prototype may be justified to demonstrate further improvements indicated by the Experimental Organic Cooled Reactor. Assuming success in the operation of the prototype, a 300-emw reactor of this type, competitive in high-fuel-cost areas, should be designable by 1965 or 1966.

Liquid-Metal-Cooled Reactors

Liquid-metal-cooled reactors have many attractive features with a high potential for achieving competitive power in wide areas of this country during the 1970's. However, there are many problems concerning fuel elements and components and an extensive research and development and reactor-construction program will be needed.

Fast Reactors. Most of the technical and economic advantages which are inherent in the use of sodium as a reactor coolant apply to fast as well as thermal reactor systems. In addition, the fast-reactor system has the potential advantage of achieving high conversion ratios or even breeding. The research and development program for fast and epithermal liquid-metal-cooled reactor systems is long range in nature and is expected to yield particularly significant results in the late 1960's. Work will be concentrated on the utilization of plutonium and U-233 as fuels and of uranium and thorium as blanket materials; on the development of efficient and rapid fuel-recycle methods; and on the development of reliable and less expensive sodium components suitable for operation at temperatures up to 1200 F.

The Experimental Breeder Reactor No. 1, the oldest of the civilian power reactors, will soon have a core containing plutonium installed. This will be the fourth core for EBR-1, which began operating in 1951. EBR-2, soon to be completed, will utilize U-235 in the form of a metallic alloy with a mixture of fission products in its first core. Some plutonium-bearing fuel will also be tested in preparation for subsequent operation on a complete core of plutonium and depleted uranium. This plant will incorporate an integrated pyrometallurgical fuel-processing facility which will minimize the reprocessing time and thus the out-of-reactor fuel inventory.

When the larger scale Enrico Fermi Fast Reactor at Monroe, Mich., becomes operable in 1961, valuable information will be developed on the uranium-molybdenum-alloy fuel performance, on fuel management, on fast-reactor core physics, and on over-all plant performance.

Two years of operating experience should be available from both EBR-2 and the Fermi reactor before the features which need to be incorporated in a new 100-emw prototype which may be justified in 1964 or 1965 can be decided upon.

Sodium-Cooled Thermal Reactors. Since sodium-cooled fast reactors now appear to offer most of the advantages of the sodium-cooled thermal systems and also the possibility of lower fuel costs through high conversion or breeding, it is not now proposed to expand the efforts on sodium-cooled thermal reactors. This position will be reviewed when operating results from the 75-emw sodium-graphite Hallam, Nebr., reactor, expected to achieve criticality early in 1962, can be evaluated. Hallam will test and evaluate promising fuels, looking toward reduction in fuel-cycle costs and demonstration of improvements in design, efficiency, and performance of sodium components.

The Sodium Reactor Experiment, shut down by fuel-element failures in July, 1959, is being returned to operation with a new core of U-235 and thorium-metal alloy. For the next few years it will be used primarily to test advance fuels for the liquid-metal-cooled systems and will indicate whether or not further experiments or prototypes of the sodium-cooled thermal systems will be justified. These will cover the entire neutron spectrum and an evaluation of the relative merits of the fast, thermal, and epithermal liquid-metal-cooled systems.

Gas-Cooled Reactors

At present, the experimental data available on the enriched-uranium gas-cooled systems are not sufficiently complete to make it possible to evaluate the economics of these systems with the same degree of reliability as is possible with even the liquid-metal-cooled systems. However, the potential appears sufficiently attractive for the AEC to continue a vigorous research and development program.

Future reactor construction in this field will depend to a great extent upon the extensive research and development program under way or planned, not only in the civilian but in the military field. The design and operating results from the Experimental Gas Cooled Reactor, EGCR, under construction at Oak Ridge, and the High Temperature Gas Cooled Reactor, HTGR, of the Philadelphia Electric Company to be constructed in Pennsylvania are also important. These two reactors will offer somewhat different approaches to the gas-cooled program. The EGCR will utilize stainless-steel-clad, slightly enriched uranium-oxide fuel, but will provide extensive facilities for testing more advanced fuels. The HTGR program is developing a core utilizing a graphite-clad fuel consisting of a homogeneous mixture of fully enriched uranium carbide and thorium carbide dispersed in graphite. The latter system shows greater economic potential than the former if satisfactory solutions can be found to the difficult problems. Significant progress is being made.

The gas-cooled reactor projects of the United States are benefiting from information-exchange agreements recently completed with the United Kingdom in regard to the Advanced Gas Cooled Reactor, AGR, and the high-temperature gas-cooled reactor known as the Dragon Project.

If justified, a 100-emw advanced prototype can be initiated in the mid-1960's.

Heavy-Water Reactors

Although this country has several heavy-water-moderated reactors under construction or planned, much will depend upon the close co-operative program with Canada. While as yet there is no heavy-water-moderated natural-uranium-fueled power reactor in the U. S. program, Canada has a 20-emw natural-uranium-fueled reactor under construction and is planning to construct a

200-emw plant. This co-operative program should be mutually beneficial and will go far toward helping to determine the future role of heavy-water reactors in this country, particularly those with natural uranium.

The AEC's Heavy Water Components Test Reactor, scheduled for criticality at the Savannah River Plant in 1961, will be used to obtain operating information on a heavy-water-moderated system under conditions suitable for power production.

Criticality of a 17-emw heavy-water-moderated and cooled pressure-tube reactor at Parr, S. C., for the Carolinas-Virginia Nuclear Power Associates, Inc., is scheduled for 1962.

Research and development are continuing on a co-operative basis in support of the 50-emw gas-cooled, heavy-water-moderated reactor of the East Central and Florida West Coast Nuclear Groups looking toward an early evaluation and a determination whether or not to proceed with construction.

The Plutonium Recycle Test Reactor which was completed this summer is primarily an experimental facility to investigate the economic feasibility of plutonium recycling. The fact that it uses heavy water as a coolant and moderator, incorporates a pressure-tube design, and operates at power-reactor temperatures, makes this reactor an important source of additional information.

Determination if a large heavy-water reactor is economically justified or whether further prototype construction is needed can be made by 1966 or 1967.

Aqueous-Homogeneous Reactors

Work will continue in the aqueous-homogeneous reactor field with research and development in the major technical areas on a long-range basis. For the immediate future, the development program will concentrate on understanding and solving the fuel-stability and corrosion problems in the core and on development of a suitable blanket material.

The Homogeneous Reactor Experiment No. 2 will aid in the solution of such basic system problems as fuel stability and maintenance of a highly radioactive primary system. It is still too early to determine whether the potential simplicity of the fuel cycle and the potential breeding factor will be more than offset by technical complexities and temperature limitations. The outcome of the research and development work, including the continued operation of the HRE-2, will make it possible to determine whether a third aqueous-homogeneous reactor experiment should be constructed. Such a decision should be possible in the 1962–1963 period, and if an experiment is constructed it should demonstrate breeding or, as a minimum, a high conversion ratio on the thorium fuel cycle. If the experiment proves successful and the economic considerations warrant it, a prototype reactor could be initiated in the late 1960's.

New Reactor Concepts

In addition to the more or less familiar reactor concepts, several new reactor types or modifications to presently developed concepts are being investigated. Engineering studies, research and development, and evaluation will be continued until a decision can be reached either to build a reactor experiment or to terminate the work. New reactor concepts will be selected for research and development when a concept offers specific advantages over other systems already under development. For example, they should offer unique qualifications for certain applications, the potential of lower cost at some point in time, extension of energy resources, or improved safety and reliability. Within the next several years, three to five new concepts are expected to reach a point where construction of an inexpensive reactor experiment of the scope of BORAX I or OMRE will be in order, with subsequent evaluation leading to prototype construction.

Supporting Activities

In addition to specific work on individual power reactor projects, there is an area of more broadly based development in nuclear technology. The general objectives are to provide basic data on reactor systems and related problems, to carry out engineering development of a general and fundamental nature, to investigate the feasibility and potential of new methods for improving reactors, and to provide tools, such as test and research reactors and remote-handling devices, for use in reactor research and development. Developments in this area should help to lower the cost of nuclear power generation through improvements affecting many types of reactors and through reductions in the over-all cost of the reactor fuel cycle. Work of this general nature will continue with some increase for the immediate future.

Conclusion

This, then, is the AEC's planned program for development of large central-station nuclear power plants over the next several years. It is estimated that an average annual expenditure of about $200 million will be required to carry out this program. This cost forecast covers research and development, design and construction of experiments and prototypes, operation costs for the prototypes, and general engineering support of the civilian program. The bulk of the expenditures will be made by the Government but the contribution of industry will be substantial and at an increasing amount.

No attempt has been made to estimate the total installed nuclear capacity in electrical megawatts of these various plants by the end of this decade. Such an estimate could be greatly influenced by the developments of the next four to five years. On the basis of plants now authorized, a total of almost 1400 emw can be reasonably forecast as being on the line by the end of 1964. Most of this will come into operation between 1960 and 1962 when 17 plants are expected to go critical. It is largely because of this that few new development projects are to be initiated within the next two years.

Evaluation is not a one-shot effort but a continuing study. Current conclusions are subject to revision as new information becomes available, new thoughts are generated, or other aspects of the total civilian power program are given closer attention. Periodic redeterminations of current status and potential of the different concepts will be necessary. Future studies will be broadened to cover areas of development, such as small power plants, which were not analyzed in the first phase of this effort. Of course, evaluation and re-evaluation depend upon progress in technology. The development of technology—not paper—is still the primary mission. However, it is only by continuing evaluation and analysis with resultant program direction or redirection that progress can be made with minimum dilution of effort and aximmum speed toward objectives.

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Associate Editor

BRIEFING THE RECORD

Bergen Generating Station

A PRESS preview of Public Service Electric and Gas Company's 580-mw Bergen Generating Station was held on September 20. Located adjacent to the New Jersey Turnpike at Ridgefield in Bergen County, it is now the second largest of the generating stations in the company system. (See cover, this issue, MECHANICAL ENGINEERING.)

Rail-delivered coal is the basic fuel of Bergen Generating Station. The secondary fuel is natural gas used when consumer demand is low since the company buys gas in bulk for its customers. Gas was burned exclusively during the start-up period of the first unit. Because Bergen is not accessible to water-borne bulk delivery of oil, it is not provided with oil-burning equipment.

All coal is delivered to the station by rail, and sufficient trackage has been provided to store 200 coal cars. The coal-handling structures consist of a rotary car dumper, thawing shed, breaker building, and swing-boom tower.

Coal in incoming cars is dumped into hoppers located in a pit approximately 46 by 65 by 40 ft deep. Coal to be reclaimed from storage enters three underground hoppers approximately 15 ft in diam. These structures are of heavy concrete construction in order to resist their inherent buoyancy and the horizontal pressures from the surrounding mud and clay strata. The coal is distributed by underground conveyers in concrete tunnels and by overhead conveyers, which, with adjacent walkways, are carried on steel trusses.

Public Service and Westinghouse Electric Corporation pioneered jointly in a new concept in large turbine generators which resulted in compactness of design and repetition of major components, thereby effecting substantial savings in initial costs. The two cross-compound, turbine-generator units used in the plant are twins. In each there is a high-pressure turbine on one shaft and an intermediate-pressure turbine on the other. Both shafts then have identical low-pressure turbines and generators.

The boilers are entirely outside the building enclosure, effecting a considerable saving in ventilation and building requirements.

Turbine Generators. The two turbine generators are cross-compound 3600/3600-rpm units with a rating of 290,000 kw and throttle steam conditions of 2350 psig and 1100 F, with reheating to 1050 F. Both elements of each cross-compound machine are alike in all respects, except that one shaft has the h-p steam cylinder and the other has the i-p steam cylinder. The l-p cylinders and the generators are duplicates. This means that the two units will have a total of four identical generators and four identical l-p elements, a feature which lends itself to compactness and savings not only in first cost of the installation, but also in spare parts. The steam turbines have 15 h-p and 13 i-p stages, and 7 stages in the quadruple-flow l-p elements. Steam for feedwater heating is extracted from two points in the h-p cylinder, three points in the i-p cylinder, and three points in the l-p cylinders, a total of eight points.

Condensers. Roughly, two thirds of the steam entering the turbine expands through all the stages and exhausts to the condenser. The other third is extracted from the turbine and reaches the condenser as drains from the feedwater heaters.

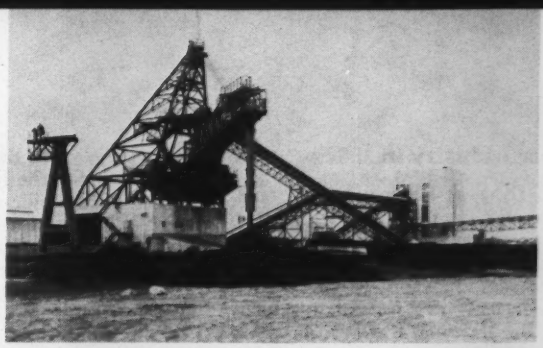
For each unit, the condensing surface is arranged in two separate welded-steel shells placed end-to-end, one under each l-p element. The water boxes of each shell are divided to permit cleaning one quarter of the condensing surface while the machine is under load. The longitudinal axis of the tubes is perpendicular to the turbine shafts. The water boxes have bottom connections and are arranged for single-pass flow.

Deaerating spill-trays are located beneath each tube-bank, and the falling condensate is scrubbed by the steam flowing upward through the trays. A vent-condenser section is located above the deaerating trays in the center of each tube-bank, and an air-cooler section is located in the center and near the top of the tube-bank. A trough is provided at the bottom of the center steam lane for distributing miscellaneous drains along the trays.

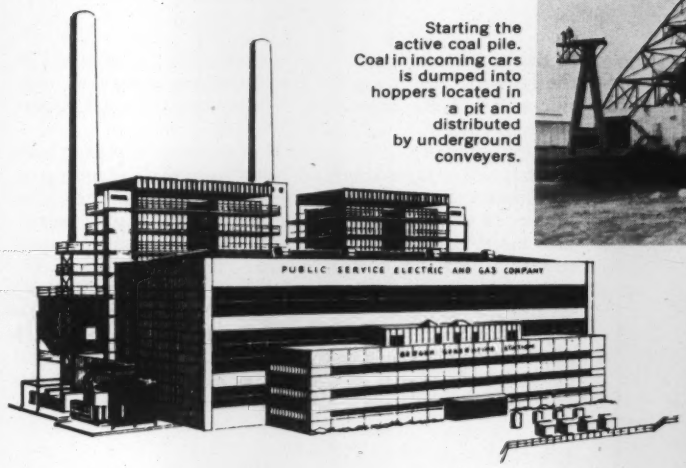
Boiler Feed Pumps. Three high-speed, half-capacity boiler feed pumps serve each unit. Two of these are driven from extensions of the two 3600-rpm generator shafts, continuing the symmetrical arrangement of components. The drive includes a 3600-rpm variable-speed hydraulic coupling and a speed-increaser designed to run at a maximum speed of 8720 rpm. The third pump, which acts as a spare, is driven by a 3600-rpm motor at constant speed through a speed-increaser. The pumps have four stages and are of the centrifugal type, with packless stuffing boxes using relatively cold condensate injection.

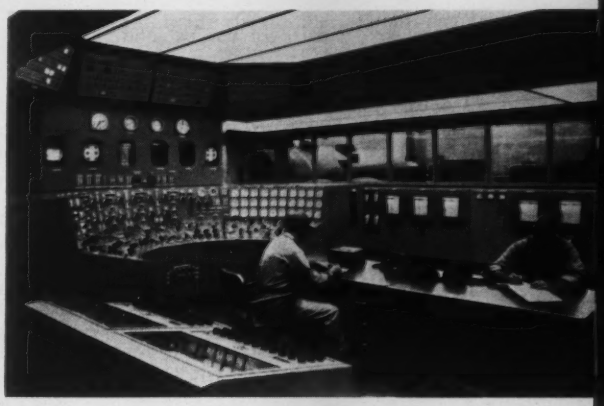
It is possible to stop the shaft-driven pumps for inspection or adjustment by withdrawing the fluid from the hydraulic coupling and applying a magnetic brake. The pumps can be disconnected during a short stop of the main unit by disengaging the gear-type mechanical coupling between the generator and hydraulic coupling.

The spare pump will sustain full boiler pressure for hot restarts following short interruptions in main-unit operation. When the spare pump is running, flow

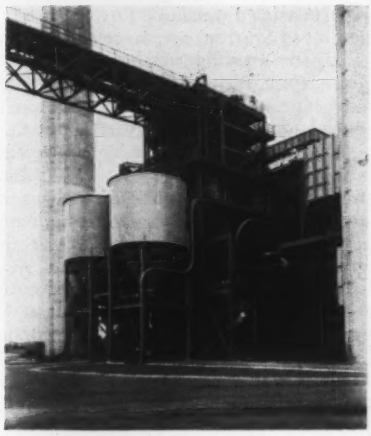


Starting the active coal pile. Coal in incoming cars is dumped into hoppers located in a pit and distributed by underground conveyers.





Control-room data loggers and control for Unit 2. Each unit is operated from a separate console.



Bergen is designed for 2350-psig and 1100 F with reheating to 1050 F. Coal is the primary fuel with natural gas secondary. Ash-dewatering tanks, coal silos, and pulverizers are shown **at right.**

control is maintained by regulation of the variable-speed, shaft-end pump which remains in service.

Since the shaft-end pumps are located in the space normally reserved for generator rotor withdrawal, a net reduction in building volume was realized, and building cost was lowered. The elimination of four 4500-hp driving motors, complete with controls and switchgear, effected additional savings.

Instruments and Controls. Each unit is operated from a separate console in the air-conditioned control room. The indications and controls necessary to start and stop all of the equipment associated with each unit are located on its console. Recorders for performance calculations and historical data are located throughout the station conveniently near the sensing points. No liquid or hazardous gas-sensing lines are brought into the control room, all signals to indicators and controls being electrically or pneumatically telemetered. Miniature strip charts are provided in the control room to give the operators trend data where required. Television has been utilized for viewing the stacks, furnace burner conditions, and boiler gage glasses. Two direct-reading drum-level indicators, viewed through a window, are located outside the control room in keeping with the philosophy of having no high-pressure lines inside the room. With the exception of the pneumatic feedwater and superheat control valves, all the boiler control drives are electric.

A digital computer is provided for rapid calculation of station performance for routine reports. It also furnishes the operators a continuous indication of deviations from important design conditions. The computer is a general-purpose machine, having a magnetic-drum memory unit with provision for external storage on punched paper tape.

A data logger is provided in the control room to keep the operators informed of important temperatures in the plant. It monitors 600 temperatures every 2 min and reports any reading above a predetermined limit. A high temperature sounds an alarm and prints, in red ink, the indentification of the temperature measured, its value, and the time. This machine can log all or part of the 600 points on demand. It can be set up to reveal temperature trends of as many as 10 points at one time.

Main Generators. Each 290,000-kw cross-compound main turbine drives two identical hydrogen-cooled generators, rated 176,000 kva, at 85 per cent power factor, with 45-psig hydrogen pressure. At 60-psig hydrogen pressure and 85 per cent power factor, the rating is 191,000 kva. The generators are 2-pole, star-connected, with 0.64 short-circuit ratio and a rating of 18 kv. They are the first on the Public Service system designed for operation at 60-psig hydrogen pressure. The rotor windings of the generators are tubular in cross section, and they are internally cooled directly by flowing hydrogen gas.

The office of Alfred Easton Poor was architectural consultant for the plant, designed by the Electrical Engineering Department of Public Service Electric and Gas Company and built by United Engineers and Constructors Inc. Sheppard T. Powell, Hon. Mem. ASME, and Associates, were water-treatment consultants. Commercial operation of unit No. 1 began in May, 1959, and of No. 2 in May, 1960.

The Power Industry in 1980

A GOOD LOOK at some of the changes in the power industry that the engineer will have to cope with in 1980 was provided by J. H. Foote, Past President AIEE, Mem. ASME, and chief engineer of Commonwealth Associates, Inc., Jackson, Mich. His talk was part of the panel discussion on the Advancement of Power Engineering at the National Power Conference in Philadelphia (see pages 129–131 of this issue of MECHANICAL ENGINEERING).

Increased density of use of land, air, and water for generation and distribution of electricity will be important factors in the electrical loads of 1980—some $2^1/_2$ to 4 times those of 1960. Rights of way are getting scarce, and the 165-ft width that is carrying perhaps 200,000 kw today will be carrying 750,000 or 1 million kw then. The engineer will have to figure out how to do it. The same factors will apply to condensing water.

As to design of the facilities, larger units in the present pattern will continue to present problems associated with temperatures of a high order and cyclic schedule. Engineers will have to figure out how to run 300 or 400-mw generating units on a schedule that looks something like the load that it is serving. The mixing of generator types—hydro and steam, for example—to fit their optimum characteristics to load requirements appears attractive. The best use can be gotten out of one and the most advantageous operation of the other in conjunction throughout the weeks and months. With the load fast outstripping the proportions of hydro available in many sections of the country, the present solution requires some more peaking hydro, storage hydro, or pump-back hydro and a lot of other things if it is going to work.

The economic problem of fuel to the generator versus electricity from the generator—mine-mouth or perhaps water-mouth—may require plants to be located away from the load just to get near fuel or condensing water. This requires constant economic study.

Another economic problem is designing for increased reliability of the components of the system to minimize idle investment. Short lines used to be built with double circuits or even two double circuits with balancing relays to accommodate 30, 40, or even 50 tripouts per year per circuit. It is time to build so that tripouts per circuit are as low as $^1/_3$ or $^1/_4$ tripouts per 100 miles per year. It can be done although it may require some special building, structurally and electrically.

Increased flexibility is another requirement, particularly in terms of such flicker loads as electric furnaces. An engineering work order used to be required every time a system was asked to supply a 2500 or 3500-kw furnace. Now that systems are getting stiffer it has to be at least a 40,000-kw furnace to require a work order. The future loads that are coming on the systems may be astounding.

The utilization of advanced mathematical disciplines in analysis and design procedures should lead to incorporation of the same discipline in the design of operating-control systems. The same mechanism and formulas utilized in the original analysis and solution of the problem can be used in systems devised to operate, dispatch, and control.

Designing equipment and facilities with adequate attention to the "amenities" will be increasingly important. Amenities is a British term for clean air, pure water, low noise, good appearance, and similar attributes. In Britain it takes up to $3^1/_2$ years just to get approval of the location and plans for a steam plant because of consideration of the amenities. Engineers should be forearmed!

The engineer will maintain his place in the power utility industry if he will build a breadth of understanding to encompass the ancillary as well as the central problems presented to him. He must understand related values and be able to measure them in terms of the over-all industry. He must understand financing—plant investments, the significance of dollars. This should lead to acceptable synthesis in the solution of problems on an industry basis. The engineer should also develop understanding of people in those disciplines that are helpful as well as the ability to manage, at least within the scope of his own assignments and responsibilities.

Little Gypsy

SOME of the economics of power-plant automation, as they pertain to Louisiana Power and Light Company's Little Gypsy Station, are described in an article by one of the company's production engineers, Lee V. Maurin, in the June, 1960, issue of *The Louisiana Engineer*.

The plant scheduled for completion in 1961 will be fully automated with a Daystrom, Inc., monitor and results computer, designed and built by the Daystrom Systems division, La Jolla, Calif. (MECHANICAL ENGINEERING, May, 1959, p. 79). Because of the prototype nature of the installation, alternate manual control by a three-man shift is provided for. In June, design had progressed very favorably. About 90 per cent of the control circuits were completed and enough of the logic flow diagrams were accomplished to indicate that no insurmountable obstacles would be encountered.

The Little Gypsy Station will be of the outdoor type with one 223-mw name plate rating single-reheat turbine with throttle steam conditions of 2000 psig and 1000 F and reheat steam at 100 F: a liquid-cooled generator with a rating of 291.5 mva; and a 1,550,000-lb-per-hr gas and oil-fired steam generator.

Savings of $84,000 for plant personnel and $18,000 for fuel represent a capitalized value, at 12.5 per cent, of $820,000—sufficient to more than offset the $700,000 increased investment over that for a conventional plant. The total cost is estimated at $1,700,000.

The reduction of the possibility of accidents offers the greatest economic justification. It is estimated that there is approximately one major accident per every three units during their life. On the average, a major accident today for a 200-mw-class unit would cost about $1 million in damage, and from two to four months' outage time. Estimating the outage at $8000 per day, the total outage cost would be increased to $1.5 to $2 million with a probability of about one in three of this accident occurring. "The minimization of this risk is valuable"; the author states, "for, although the company has never suffered a major accident, the present-day units are becoming larger and more complex, thus causing the probability to increase unless preventative steps are taken."

Additional savings of $32,000 for reduced maintenance and another $64,000 for minor outages were also estimated.

The Little Gypsy plant will have all the conventional, but solid-state, analog control subloops, such as combustion control, superheat control, and the like; with

the computer stepping in to optimize these loops and to take over the controls to safely operate the plant in the event of malfunction of any or all of these subloops.

Many of these control subloops do not become effective until the unit is operating at over 20 per cent rating, so that the computer will be solely responsible for the safe operation of the plant at those times when the plant is operating below 20 per cent rating. It is to be hoped, and expected, that the industrial digital computer will prove its reliability and availability, in the future, to such an extent that it will be feasible to realize the savings possible in eliminating all control subloops and allowing the computer to completely perform the tasks normally assigned to these subloops. This savings would be appreciable and could be a major factor in the justification, on a sound engineering basis, of a computer installation.

It was also deemed wise to retain possible full manual control of the plant in the event of simultaneous computer and control subloop failure while in operation above 20 per cent rating or computer failure only in operation below 20 per cent rating.

The projected ultimate size of this station will be six units with a total capability of 2 million kw; and it is hoped that the number of plant employees will not have to be increased appreciably. It is not beyond the realm of possibility to assume that this six-unit station could be controlled by three men—a control supervisor, a control operator observing the operation of the plant and taking over in the event of a unit computer failure, and, finally, a roving operator to be utilized wherever necessary.

Centriline Fan

A CENTRILINE fan which combines the advantages of airfoil-bladed centrifugal-fan performance with the space-saving features of straight-line air flow has been introduced by the Sturtevant Division of Westinghouse Electric Corporation, Boston, Mass. With it, air-conditioning and air-handling fans can be installed in less than half the space previously required by conventional scroll-type units. The noise encountered with axial fans is also minimized.

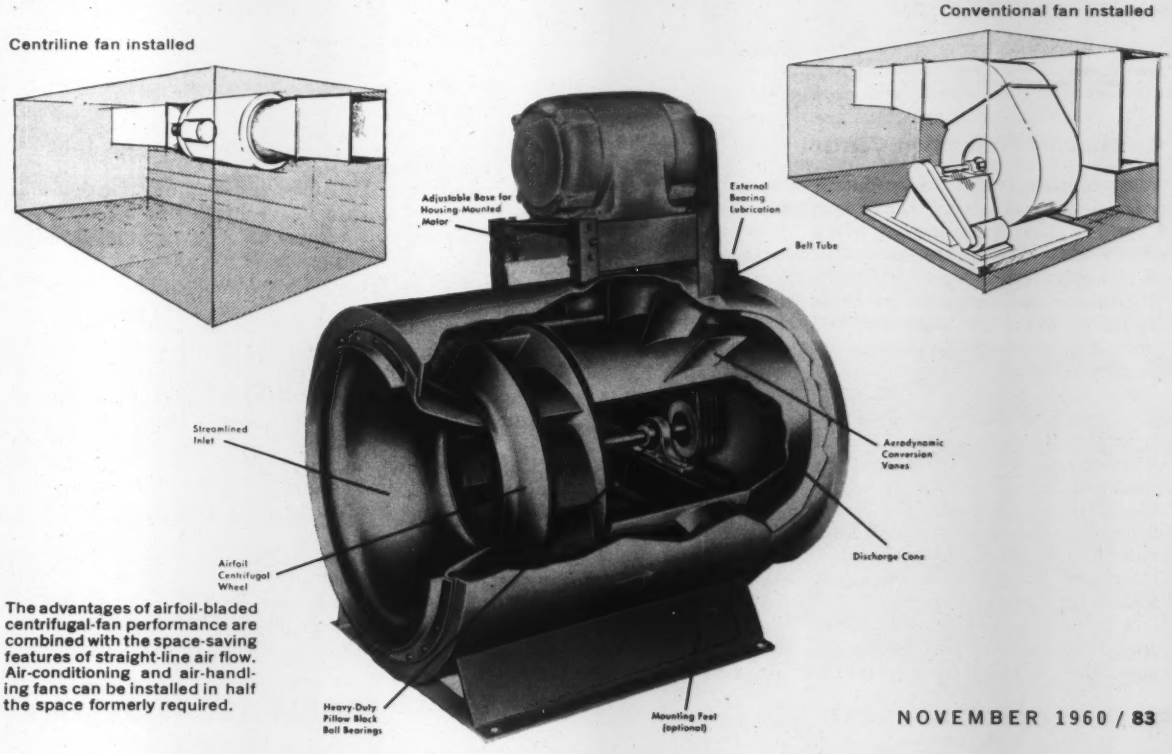
Units can be ceiling mounted, wall mounted, or stacked, freeing otherwise wasted floor space. In effect, more supply and exhaust systems may be installed in the same space thereby minimizing the number of equipment rooms required. Installation is simpler because inlet and outlet dimensions are the same and one-size duct may be used. Both entrance and discharge elbows are eliminated by the straight-line air-flow design, adding to efficiency as well as saving space.

The Centriline fan is available in sizes with airfoil wheels from 27 to 44 1/2 in. in diam. Volumes range from 4740 to 46,800 cfm, pressures up to 9 in. of water static.

Coal Productivity

FINAL statistics for the nation's bituminous coal and lignite industry in 1959, released by the Bureau of Mines, show an increase of 0.4 per cent over the 410.4-million-ton output recorded in 1958. Last year's extended steel strike and cutbacks in coal exports were largely responsible for the relatively small gain.

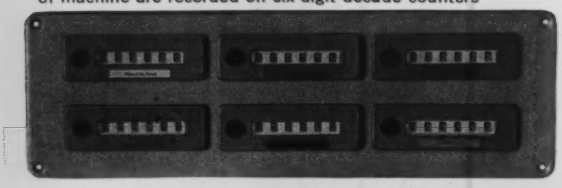
Productivity reached a new high of more than 12 tons of coal per man per day, an advance attributed mainly to increased mechanization. According to the Bureau, a record 86 per cent of coal produced underground was loaded mechanically in 1959. The increase in output per man day is nearly a ton over 1958, when slightly less than 85 per cent of underground production was loaded mechanically.



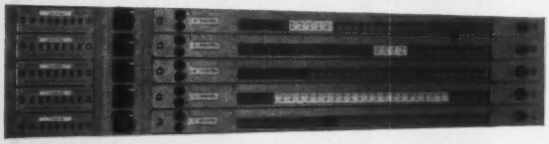
The advantages of airfoil-bladed centrifugal-fan performance are combined with the space-saving features of straight-line air flow. Air-conditioning and air-handling fans can be installed in half the space formerly required.

PRODUCTION CONTROL

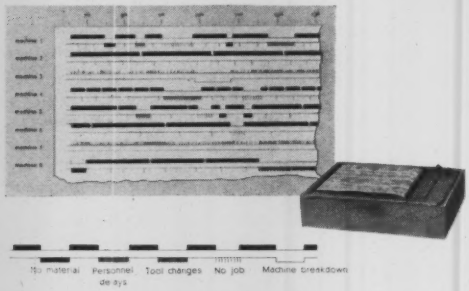
Totalizer. The total running and down times for each category of machine are recorded on six-digit decade counters



Linear Counter. A mechanical Gantt chart or bar graph visually displays the minute-by-minute progress of production on each machine. As production increases, a blue bar travels from left to right across the graph until it meets the yellow bar, preset from right to left, which indicates the production quota. Overlap indicates excess over quota.

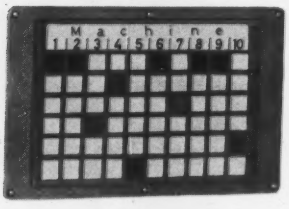


Graphic Recorder. Production time and down time for each machine is continuously charted on adjoining tracks, with the cause for the down time indicated in code on the lower track.



The modular Productograph components can be combined into a console adapted to any plant. Here linear counters, totalizers, and time counters are at rear, while other units are combined into a desk-type supervisory control unit.

Lamp Field. Operating status of any machine can be checked by a glance at the lamp field. Light in top row indicates that the machine is operating, other rows indicate down-time cause.



Continuous Production Control

A MODULAR system of production-control devices has been demonstrated by the Farrington Manufacturing Company, Needham Heights, Mass. It provides a single supervisor with a continuous and instantaneous summary of the operation of up to 200 production machines.

Invented and developed in Erlangen, West Germany, by Joseph Mayr, the units will be manufactured in West Germany until production can be established at the Farrington plant.

Four basic custom modules can be combined in a single console receiving unit of a size suited to the production operation. There are graphic recorders which continuously chart the production time and down time of individual machines, 6-digit decade-counter totalizers which record total running and down times for each category of machine, linear counters which provide a bar graph of production in relation to quota, and a lamp field which shows which machines are running, which are down and why.

A telephone system gives the controller instant contact with machine operators, supervisors, and departments. When an operator calls in, a visual signal indicates which machine is calling and a tape recorder makes a record of the call.

The graphic recorder shows the running time of a machine in minutes with a heavy black line on an upper track. For each void a lower track records the reason in a code marking indicating one of five reasons—no material, personnel delays, tool changes, no job, or machine breakdown.

The linear counters are mechanical Gantt charts. A yellow bar manually preset from right to left to any point along the graph indicates the production quota for that machine. A blue bar travels from left to right as production increases. The white area between the two indicates the gap. When the quota has been reached the bars meet, and they overlap as the quota is exceeded. A continuous and instantaneous graphic report of the production of each machine in relation to its quota is thus provided.

Over 200 are installed in West Germany. There are presently two Productograph installations in this country—at the Holo-Krome Screw Corporation (a subsidiary of Veeder-Root, Inc.), Hartford, Conn., and at the Connecticut Bending and Stamping Works, New Britain, Conn.

New Thermoelectric Alloy

ONE of the most efficient thermoelectric materials yet developed is composed of the elements silver, antimony, and tellurium. Its chemical designation is silver antimony telluride, $AgSbTe_2$. The compound was first discovered by J. H. Wernick of Bell Laboratories, as disclosed at the International Conference on Semiconductors at Prague, Czechoslovakia.

Many compounds, and alloys of compounds, some with as many as seven elements, have been produced and studied in the search for improved thermoelectric materials. Silver antimony telluride is claimed to be the best of these discovered to date.

Stoichiometric quantities of the desired elements are directly fused and zone refining is then used to produce pure samples.

The material possesses a very low thermal conductivity, necessary in order to maintain a temperature differential between two ends of a device. Its thermoelectric figure of merit, Z, has recently been measured by scientists at Radio Corporation of America, and is reported to be about 1.75×10^{-3} per deg C over a range of 200 to 500 C, which is the best yet observed for P-type thermoelements in this range.

In the current studies, silver antimony telluride was described as having a disordered cubic structure, exhibiting a thermal conductivity as low as 0.0064 watts per cm per deg C at room temperature, only $^1/_{100}$ that of germanium. While the material is always thermoelectrically P-type, its Hall effect is P-type in some specimens, and N-type in others, even when taken from a single ingot.

Electric-Arc Heater

A STREAM of gas at as much as 20,000 F and 15,000 psi can be supplied by an electric-arc heater devised by the Westinghouse Electric Corporation. John A. Hutcheson, Mem. ASME, vice-president in charge of engineering for Westinghouse, credited the new arc heater with being the first to operate continuously and at a low level of gas contamination. This is now guaranteed at 0.2 per cent max and further reductions are contemplated.

The arc heater has immediate wind-tunnel applications for missile re-entry testing and holds promise as a chemical synthesizer and as a furnace for processing metals with ultrahigh melting points. A prototype operated at 1700-kw power input, but 30,000 kw is planned.

"The temperature into the nozzle has been maintained at 10,000 F—approximately as hot as the surface of the sun," Dr. Hutcheson said. "In addition, flow from the nozzle of the unit has reached a sonic velocity of 3400 mph. Velocities over ten times the speed of sound can be expected when the gases are expanded with a hypersonic exhaust nozzle."

As a chemical synthesizer, nitrogen and oxygen, for instance, could be combined in the heat chamber to form nitrous oxide, a compound widely used in chemical processing. A synthesizer of this type could also find application in processing petroleum products.

As a furnace, the unit may make a number of refractory metals such as tungsten available in ingot form for the first time. Normally used in powder form, these are difficult to process because of their high melting points.

It is believed that the Westinghouse arc heater has a uniform temperature "profile" within the heat chamber. In other words, the temperature at the entrance to the nozzle is constant.

The basic concept was proposed by Werner Emmerich, physicist, Westinghouse research laboratories.

Two electrodes form the terminals for the arc. Each consists of a hollow doughnut-shaped ring placed horizontally, one directly above the other. Water is pumped through the hollow rings for cooling.

An electric arc is started by drawing it across the gap between the two rings, and then rotating it around the gap at a high rate of speed.

Rotation of the arc is accomplished by a magnetic field from d-c coils arranged around the outside of the heat chamber. This rotation, combined with water cooling, prevents the electrodes from heating to a point beyond the structural endurance of the material and acting as a source of contamination.

The working fluid, such as air or nitrogen, enters the arc chamber and passes into the arc through openings near a water-cooled copper heat shield which protects the walls of the arc chamber and can withstand arc temperatures well above 10,000 F without eroding. The fluid passes from the arc through a water-cooled nozzle.

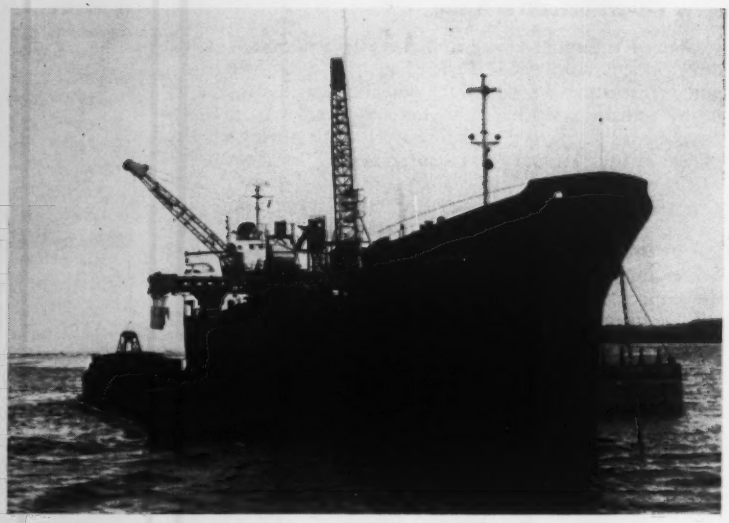
The prototype of the new unit, designed and built by a group of engineers headed by Armin Bruning, accommodates a 1.2-lb-per-sec flow of either air or nitrogen. The unit should be able to supply gas at 1500 psi with a constant enthalpy of more than 2000 Btu per lb for as long as 10 min without damage or measurable gas contamination. The efficiency of heat transfer to the gas is in excess of 50 per cent. A variation of the prototype model is now available to the aircraft industry.

So far, the highest pressure at which tests have been conducted is 730 psi. Other tests with a power input of 549 volts and 5046 amps (9450 kw per lb per sec) have raised the enthalpy of air passing through the chamber 4670 Btu per lb. Equipment of this type can use either d-c or a-c, single or three phase.

A variation of the prototype is now available to the aircraft industry and advances in arc-heater technology should permit equipment to be supplied to the metal, chemical, and petroleum industries within one or two years. Presently, these industries have no practical means of producing temperatures of 10,000 to 20,000 F in gases at high pressure over a sustained period of time.

Depending on wind-tunnel-facility power requirements, an arc heater with its power supply may cost from $500,000 to $1.5 million.

Main components of an electric-arc heater, which can supply 20,000-F and 15,000-psi gas, are an arc chamber and a power supply. The arc chamber consists of a heavy steel envelope in which electrodes, magnetic arc-rotator coil, nozzle, and auxiliary equipment are housed.



No port or dock facilities are needed to load or unload a new bulk-cargo vessel. Built-in conveyers can charge or discharge bulk materials at 2800 tons per hr from or to other vessels or shore storage.

Self-Loading and Unloading Ship

A NEW kind of bulk-cargo vessel which can load and unload by conveyer without the aid of port or dock facilities is now operating in the Gulf of Mexico. First ship of its type, the *S. S. Martha Mac* is designed to discharge or pick up bulk materials at a rate of 2800 tons per hr from or to other vessels or shore storage piles, eliminating expensive land-based facilities.

The equipment which makes this unique method of material handling possible was designed by Hewitt-Robins, Inc., manufacturer of material-handling systems. It consists of a "closed-circuit" 54-in-wide conveyer system circling the top deck, two traveling track hoppers with belt feeders, two traveling swinging tripper-boom stackers (one on each side) fitted with telescoping delivery chutes, and two revolving electric cranes equipped with clamshell buckets with a capacity of $9\frac{1}{2}$ cu yd.

When unloading, the cranes with their outsize clamshells bring the bulk material up from the cargo holds and dump it into track hoppers. These feed the material to the conveyer system which in turn feeds it to the outrigged traveling trippers. Each stacker can be adjusted to trim barges while discharging or to maintain a fixed position while discharging to shore.

When loading, the cranes pick up the material from other cargo vessels, or from shore storage, and dump it into the track hoppers. The conveyers then carry it to the traveling tripper booms or stackers, which have been swung inboard, to deliver it to the hatch of the desired cargo hold. The ship can load or unload from either side or from both sides simultaneously. She can simultaneously handle one type of bulk material from one side of the ship and another type from the other. Each swinging boom tripper can feed the preceding cross belt so that 100 per cent capacity is loaded or unloaded from one side of the vessel.

Owned by the Gulfcoast Transit Company, the *Martha Mac* is a converted T-2 type oil tanker. The conversion included the removal of bulkheads that formerly divided the hull into 26 tanks and the installation of new bulkheads to form four huge cargo holds plus steel hatch covers for the holds. The midship house was removed and the afterhouse was enlarged to accommodate a wheelhouse and crew quarters. The ship is now being used in Gulf of Mexico service to transport phosphate from Florida to the lower end of the Mississippi River near New Orleans where she unloads the phosphate onto barges for delivery north. Once unloaded, she picks up coal and other bulk materials that have been barged down the Mississippi for delivery to Gulf ports.

The *Martha Mac's* hull is 523 ft 6 in. long over-all, 65 ft wide, and 28 ft 3 in. deep. Her four holds have a capacity of 15,300 tons. She is powered by a 6600-hp steam, turbine-electric plant.

Although Hewitt-Robins has designed and manufactured conveyer equipment for more than 60 self-unloaders, this is the first ever built that can both load and unload without land-based facilities. The *Martha Mac's* capacity of 2800 tons per hr is not high as self-loaders go (Hewitt-Robins has built them to unload at 6000 tons per hr), but the new design is efficient and economical for the purpose.

The "Plowshare" Program

IN THE hearings on "Frontiers in Atomic Research" before the subcommittee on research and development of the Joint Committee on Atomic Energy of the U. S. Congress, additional information was given on the Plowshare program. This would develop peaceful uses for nuclear explosives using them for excavation on an unprecedented scale, for the release of oil in oil sands, and for a number of other purposes.

Basic Research. Research studies made at Los Alamos and Livermore indicate that elements of very high atomic

number and some neutron-rich unstable elements can be obtained in larger quantities by nuclear explosions than in any other way. The study of these artificial elements can reveal a great deal concerning nuclear structure. Fission resonances of U-235 may be better studied by nuclear explosions. Neutron spectroscopy experiments, seismology studies, and other similar studies can also be made. Chemical and isotope production is another possibility.

Chemical Uses. A megaton detonation releases thermal energy equivalent to that produced when 150,000 tons of coal are burned, and temperatures of 10,000 F are available to form simple compounds. Elements such as aluminum and silicon will quickly form certain oxides not ordinarily existing at normal temperatures, and at progressively lower temperatures (below 10,000 F) other chemical combinations occur. Depending on the composition of the original matter vaporized in the detonation, new compounds formed may be quite different from those originally present.

Energy Production. Various ideas have been suggested for the conversion of the energy released in nuclear explosions into usable heat. The simplest scheme is based on the observed results from underground nuclear explosions that about one third of the energy released is deposited in melted rock at high temperatures. It is proposed that nuclear explosions in salt domes would produce large pools of melted salt which then could be tapped for this stored energy by use of a driving fluid such as water in pipes. The resulting steam or hot gas could be used for power purposes. Another method would be to use nuclear detonations to release geothermal energy which could also be exploited by using a transfer fluid.

Mineral Recovery. Project Oilsand is proposed to use nuclear energy underground to release large oil deposits trapped in oil-sand formations which are located in the Athabaska area of Alberta, Canada. Geologic and stratigraphic data from wells drilled in the Athabaska area indicate oil sands of at least 17,000 sq miles in area which may contain 600 billion bbl of oil. A certain amount of research is necessary for such things as degree of radioactive contamination, mechanism of heat distribution to release the oil in the cavity, cracking the oil, and similar matters.

Mining by use of nuclear explosions has the following possible approaches: (*a*) Breaking and removing the overburden before the mining of the ore body is undertaken, (*b*) breaking the ore in preparation for open-pit mining, (*c*) breaking ore and cap rock to facilitate block caving, (*d*) breaking ore to permit the circulation of solutions through the broken ore in order to extract the valuable minerals chemically, (*e*) breaking oil shale to permit its being retorted underground without the necessity of mining.

Experimentation on barren rock with the same physical characteristics as the ore bodies should be done first to avoid gambling with our natural resources.

Excavation. The use of nuclear explosions for earth-moving purposes seems to offer the most promise. The areas in which the excavating potentialities can be exploited are the construction of harbors, canals, and other waterways, and the damming of rivers or streams and similar projects.

The AEC published data in September, 1958, concerning costs of usable devices for nuclear detonations (UCRL 5253, "Industrial Uses of Nuclear Explosives"). A 30-in-diam fission device with the energy yield equivalence of a few thousand tons of chemical explosive would cost about $500,000 for fabrication and firing when made in small numbers. For similar conditions but with several tons or kiloton yield the cost would be about $750,000.

These costs do not include preparation of site or studies for industrial utilization. It is estimated that costs for excavating harbors and canals which do not require great depths would be about a factor of 10 less than conventional costs.

A chemical-explosives cratering program is proposed first to develop scaling laws, dependence of crater dimensions on depth of burial and nature of the medium, and to determine placement of multiple charges and other effects. This would be followed by a nuclear-explosives cratering program to correlate these studies with what was learned in the chemical-explosives studies, to obtain data on the effectiveness of containment and localization of radioactivity.

Water-Resource Development. Nuclear explosives could aid in developing water resources either by direct cratering or by collapsing canyon walls to build earth dams. Storage of water underground and uniting permeable zones with impermeable ones are also proposed. The question of takeup and migration of radioactivity in water will be thoroughly investigated at each site prior to setting off an explosion.

Electric-Auto Test

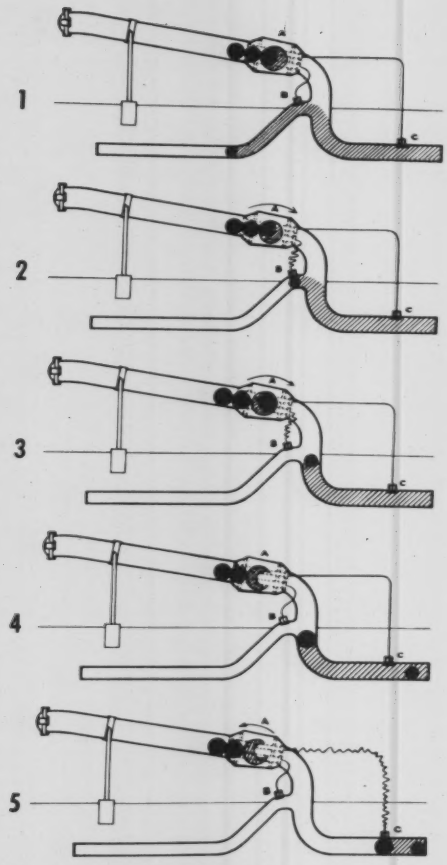
THE Henney Kilowatt, an electric automobile chassis with a Renault Dauphine body (MECHANICAL ENGINEERING, June, 1960, p. 81) has been traffic tested by H. Drake Harkins, Fellow ASME. The power plant, engineered by Eureka Williams Corporation, consists of one 7.1-hp G-E motor, 12 Exide "Golf Giant" 6-volt batteries, and a six-step contactor speed control. Both 12-volt and 72-volt chargers with extension cord are built into the car. There is a 12-volt battery for lights and other auxiliaries.

The car was put to normal use for family errands, social visits, and so forth. Although "speed was never an embarrassment"—the car cruises at exactly 25 mph on 36 volts, top speed is 32 mph on level roads—the Kilowatt was frequently the first away and first at the next red light. It is suggested that a small change in gear ratio could increase top speed to 35 mph or better and is well within the capabilities of the power plant.

Mileage averaged 15.4 per calendar day—"about normal for a stay-at-home second car." Minimum day was 2 miles, maximum 51 (when tested to near-exhaustion of batteries). Mr. Harkins commented that because the car was "on test" probably 20 per cent of the total mileage was in excess of "normal." On the maximum day if the batteries had been recharged between trips, the available range would have been increased about 50 per cent to 75 miles.

Cost of the electricity was only 0.8¢ per mile based on a total input to the battery chargers of 175 kwhr for the 400-mile test, 2.28 miles per kwhr, and electricity at 1.82¢ per kwhr. This would be the equivalent of 37.5 miles per gal with 30-cent gasoline.

Mr. Harkins concluded enthusiastically that the 26-day test in the Atlantic City and Ocean City area of New Jersey proved that "a practical electric automobile is here today . . . One hour's driving in city traffic will prove its case!"



Purging Pipelines Automatically

1 Small ball approaches end of 16-in. line, which it fits, to get a larger ball to purge the oncoming 18-in. portion of the line

2 The 16-in. ball trips electric switch **B**, starting the opening of the Rockwell-Nordstrom Hypresphere valve containing the 18-in. ball

3 Large ball swings around in basket in valve's plug **A** as small ball continues on its way

4 Large ball begins to sweep large line. Small ball, now superfluous, goes ahead but is too small to trip the valve-closing switch **C**.

5 Large ball trips switch **C** to begin valve closing and ready it for the next launching

Pipelines Automatically Purged

THE only manual operation in a new purging technique for both single and multisize gas pipelines is the return of the rubber pigs from the receiver to the launchers.

Pigging removes the liquid which collects in low spots along the line without the need of numerous drip installations. Since pockets of liquid tend to retard the flow of gas, pigging helps make the pipeline more efficient and reduces the power required to carry the gas.

Key to the automatic pigging is a new type of launcher which is based on a special modification of the Rockwell Hypresphere valve. Inflated neoprene balls are stacked on an incline against the valve, which is similar to other Hypresphere valves but has one end of the port through the plug closed off to create a pocket. The bottom ball in the stack rolls into the pocket, ready to be launched. When the valve is turned 180 deg the ball is swung around and out to drop into the pipeline where it is propelled by the line pressure.

In multisize lines, launchers are placed at each point of line-size change. When a 16-in. ball approaches the point where the line grows to 18 in., a signal is tripped which operates the valve, dropping an 18-in. ball right behind the smaller one. The bigger ball trips another signal (which the smaller one didn't touch), turning the valve back to its original position. Another spheroid drops into the pocket, and the launcher is ready for the next purging cycle.

Since the valve, being closed at one end, provides a positive seal against the gas at all times, it must hold against full line differential but it needn't operate against it. The valve is operated by the line pressure through 4-cyl hydraulic operators.

The Hypresphere is a spherical-type valve containing four main parts—the operating stem, the ball plug, two spherical ring seats, and the body housing. Only the operating stem and ball plug move. The valve operates on a rotating principle and opens and closes with an easy quarter turn. The sphere fits snugly into the seat rings with uniform pressure, insuring a positive shut-off which is necessary to prevent gas leakage through the launchers when neoprene balls are reloaded into launcher barrel.

The system has only one receiver—at the end of the line. The balls are allowed to pile up in the receiver barrel, while a rising gas line carries the gas into the main gathering system, leaving the liquid to go into the liquid storage area. A standard 90-deg rotating hypresphere valve provides positive shut-off of the gas while the balls are unloaded for return to the launchers.

Colorado Interstate Gas Company, which pioneered the new pigging system, reports that flow efficiency has been greatly increased and the previous problem of pressure build-up was eliminated.

The company has had liquid recovery as high as 650,000 gal in a six-week period.

Long-Term Fuel-Cell Research

A LONG-TERM research program to advance fuel-cell technology, described as "a major research effort being underwritten by some 25 companies," has been initiated at Battelle Memorial Institute, Columbus, Ohio. Major American and European chemical, petroleum, transportation, mechanical equipment, public utilities, and engine and automotive manufacturers are supporting the work.

The program, presently on a five-year schedule, "will be fundamental in nature and is designed to complement existing government, industrial, and academic studies on fuel-cell technology," according to John McCallum, project director. "Before the fuel cell's full potential can be realized as a source of power for automobiles, domestic heating and cooling, and industrial processes," Dr. McCallum said, "there will have to be a number of inventions, innovations, and break-throughs. Battelle, with its diversity of scientific disciplines, hopes to contribute to this process of discovery."

The prime advantage of the fuel cell is the remarkable efficiency with which it can convert fuel to energy. Efficiencies of 75 per cent have been demonstrated experimentally as compared with 40 per cent in steam turbines,

35 per cent in diesels, and 25 per cent in spark-ignition engines. The fuel cell also offers an attractive energy-to-weight ratio, no moving parts, simplicity in design, adaptability to specific space and shape requirements, and a minimum of mechanical maintenance. It is silent, gives off no objectionable waste products, and can probably be adapted to a wide variety of fuels.

Much of Battelle's research on the fuel cell will be aimed at obtaining a better understanding of the properties of materials required in a cell and developing materials which approach the ideal. It is hoped that a study of the internal electric structure of alloys will lead to development of an alloy composition with unique electrical and electrochemical properties for cell electrodes.

Another approach will be the study of thin films of metals. Thickness of such films greatly affects their properties. A better knowledge of these properties may be a significant factor in the selection of the right combination of materials for more efficient fuel cells.

Other phases of the research program will include study of active-carbon electrodes with metal-chelate surfaces and the use of unusual plating techniques to apply porous metal surfaces to electroformed electrodes for the cell. Concurrent with the experimental work, Battelle will collect and interpret new data on fuel cells for the use of participating companies, drawing information from all available sources.

Carload Sugar Handling

A rotary car dumper that also rolls up a 30-deg incline is used in a new raw-sugar unloading system at the National Sugar Refining Company's Philadelphia refinery along the Delaware River. Raw sugar is received in bulk thus solving the twin problems of limited availability of bag sugar and the slow and costly unloading and warehousing of it.

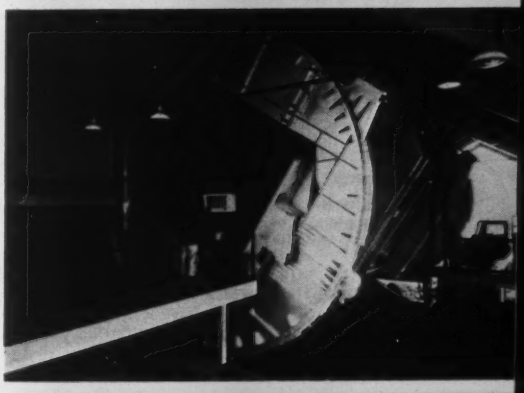
Operating in an extremely limited space, the new system has already handled 560 tons in one 47-min period. An optimum capacity of 600 tons per hr is expected with the installation of Syntron vibrators and with proper scheduling of cars.

The system was designed and constructed by the Austin Company to cope with a tightly restricted unloading area which precluded the use of a standard rotary car dumper and the need for a waterproof receiving pit. The cost of a waterproof pit below tide level to house the receiving hoppers would have been prohibitive.

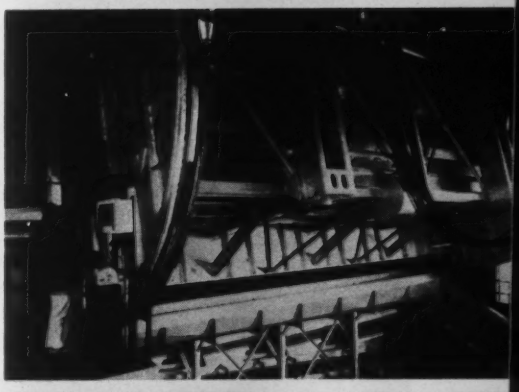
To conserve space, track work was built on a trestle, with the tracks 10 ft above mean high water. It was then possible to deliver the 70-ton hopper cars to the car dumper. The dumper rolls the cars up a 30-deg incline to a height of $17\frac{1}{2}$ ft so that they can discharge sugar into hoppers located well above tide level. In maximum dumping position, the car is at a 150-deg incline from the vertical. The total dumping cycle takes 3 min, not counting time for spotting and removing cars or for cleaning and washing them. From the hoppers the sugar is fed into two belt feeders and then to a 600-ton-per-hr belt conveyer that delivers the sugar to a warehouse for processing or storage.

Engineers of Link-Belt Company, who collaborated with the Austin organization designed the special car dumper. It consists of a $49\frac{1}{2}$-ft-long transfer table arranged to handle up to 70-ton standard-gage open-hopper railroad cars. Gross weight of the dumper, including a car, is approximately 97 tons.

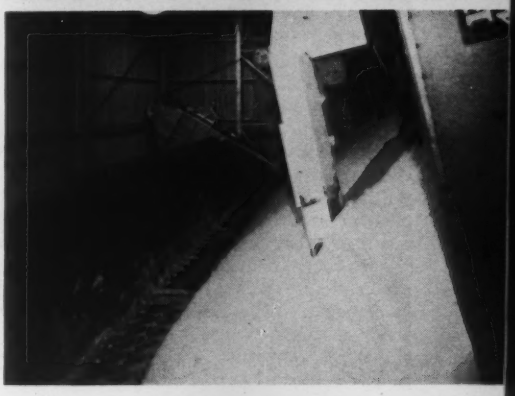
1 Because there was not enough room for a long trestle to achieve sufficient elevation above tide level in a riverside plant, this special rotary car dumper was designed



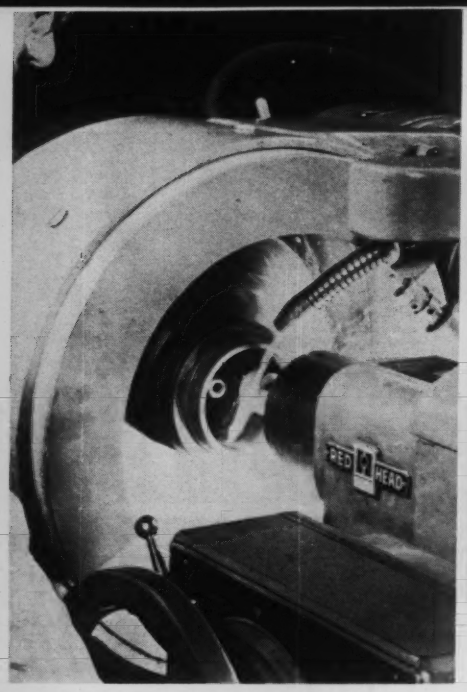
2 The whole dumper, designed by the Link-Belt Co. ascends a 30-deg incline while rotating. This raises the cars $17\frac{1}{2}$ ft to reach the hoppers.



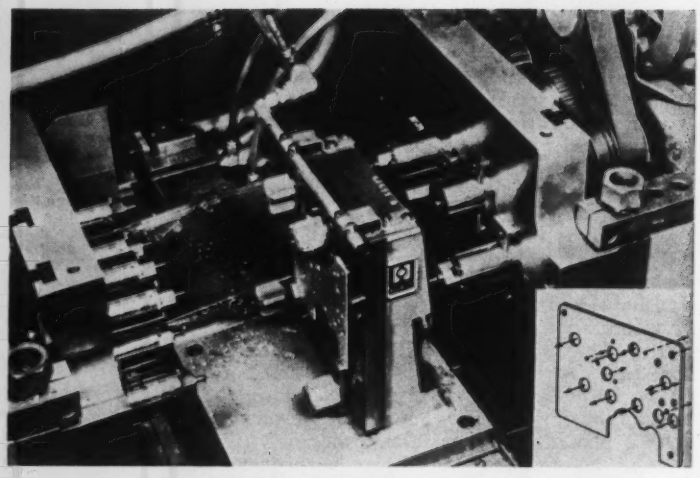
3 As the dumper reaches the top of the incline, the track seen at lower right, the car has been tilted past the vertical



4 Raw sugar pours out of the tilted car at the rate of more than 560 tons per hr. Tide level determined hopper height.



Typical of the advantages inherent in today's boring and grinding equipment are high cutting speeds and precision operation, coupled with advanced design



Multispindle boring heads produce 23 holes in an aluminum gearbox plate at the rate of 10 parts per hr. One set of boring heads performs first two operations, then spindle plates change to produce the final 12 holes.

Progress in Boring and Grinding

DURING the past five years, precision boring and grinding have made tremendous strides. Major innovations cited by A. Francis Townsend, vice-president, engineering and development, the Heald Machine Company, speaking at the National Tool Exhibition in Chicago in September include: Combining machining operations via transfer lines; application of numerical control; high-production wheelheads capable of operating at speeds up to 150,000 rpm; development of systems-engineered internal grinders for bores as small as 0.040 in.; continued advances in automatic loading, gaging, and chucking to reduce operator attention and cycle time; and machine-design concepts which afford increased rigidity, power accuracy, and productivity.

Dramatic advantages have resulted; machines developed within the past two years outdate all previous equipment for some classes of work and have frequently doubled production. Increased emphasis on ceramic cutting tools has resulted in heavy-duty machines rigid enough to supply roughly $2^1/_2$ times the cutting speed necessary with carbides. Cutting tests with ceramics on cast iron showed 2850 surface fpm possible—one mile of cutting with 0.006-in. wear land at 0.010-in. lead. On SAE 4150 steel at 1000 surface fpm at 0.005-in. lead, tests ran 13,300 ft with 0.009-in. wear land. According to Heald engineers, today's machine tools can operate faster than the best tools available can cut. Temporarily, at least, this should answer the question as to whether better metalworking machinery or improved cutting tools form the barrier to even heavier cuts and faster metal-removal rates.

Designers of precision grinding and boring machines aim toward the perfection of infinite rigidity and zero cycle time. Optimum balance is sought between high stock-removal rate and quality of finish. A measure of their progress within the past five years can be found in the following achievements:

High Speed Wheelheads and Multispindle Boringheads. Accuracy and economy begin at the spindle—the business end of precision boring and grinding machines. Capable of generating spindle speeds of 45,000 to 100,000 rpm, interchangeable cartridge-type wheelheads mark a new plateau in efficiency and accuracy for grinding small-diameter bores. Ease of cartridge interchange and simplicity of speed-range selection make these units practical where frequent setup change-overs are necessary, as well as for long production runs. The new wheelheads, both belt and air-driven, eliminate the need for high-frequency generating equipment and offer spindle life comparable to that of high-frequency wheelheads.

Until recently, precision boring of closely spaced multiple holes was a slow and expensive task that required highly skilled operators. Jobs of this type are now done on a mass-production basis with multispindle boringheads. These consist of interchangeable spindle plates, precision bored to spindles. Minimum center-to-center distance can be as close as $^3/_4$-in. and job change-over accomplished by switching spindle plates. Highly flexible cluster heads eliminate indexing and allow completion in minutes of jobs that previously took 8 to 10 hr on jig borers.

New Production Principles. Because of their inflexibility, transfer machines pose a prime cost problem in automated production lines. The building-block design philosophy provides industry with a reliable solution to the economic problems of instituting design change-overs or new products.

Unitized machine tools are playing an important role in the trend toward industry standards for building-block components. Units can be individually tooled for the job at hand, and adapted afterward—with a minimum of rearrangement and structural changes—for new operations. Hundreds of combinations are available and machines can be mounted on slide units to approach the work from any angle. This versatility cuts production costs and protects against early obsolescence when planning a long-term investment in capital equipment.

Numerically controlled boring and grinding equip-

ment is setting new performance capabilities, especially for small lots on standard equipment. Programming machining cycles provides distinct advantages: Uniform part quality and less inspection; reduced lead time through elimination of fixtures, templates, and special gages; quick job change-over; elimination of expensive tooling and automatic special-purpose machine tools; maximum efficiency through complete control of cutting action and reduced operator attention.

Planned job analysis through coded data has also broadened design horizons. Contouring, by means of the highly developed continuous-path system, is an established technique. Here machine slide movements are co-ordinated and the restrictions of orthogonal production methods removed. With the extension of numerical control to precision boring machines, free-form shapes are now generated with dimensional tolerances of ±0.0001 in.

Mounting the wheelhead on a table inclined at an angle of 30 deg represents a recent major break-through in the art of precision grinding. This new principle provides positive backup against wheel pressure. Faster stock-removal rates cut cycle time—up to 50 per cent for large-size work.

"Given a proportionately stiff quill," Mr. Townsend pointed out, "we can now grind as fast as the wheel and work can take the load."

Special Machines for Special Jobs. The machine-tool manufacturer must frequently cope with complex process requirements for specialized segments of industry. When inordinately large components are involved, as in missile and aircraft production, the problem is one of basic economics. The capital outlay for correspondingly large machine tools is often prohibitive.

Where a machine offers the versatility to simplify and perform multiple operations, the initial investment is more than justified. Typical is a huge vertical machine designed recently for jet-engine parts overhaul. Combining a grinding head and metal-cutting turret, the unit is adaptable for such diverse operations as grinding, boring, facing, and turning. Equivalent efficiency would require two machines—a vertical grinder or gap-type grinder, plus a lathe. Setups for large parts are also more practical on vertical equipment.

At the other end of the size scale, miniature-bearing manufacturing also poses special problems. Especially developed for grinding miniature-bearing races, a systems-engineered internal grinder generates the highest wheelhead speeds presently available (150,000 rpm) and enables finishing ID to be as small as 0.040 in. Tolerances of 0.00015-in. and 5-microin. finish are obtained in a fully automatic 15-sec cycle.

Tensile-Test Cryostat

TENSILE STRENGTHS of materials at temperatures near absolute zero are now determinable with a special cryostat recently developed by Arthur D. Little, Inc., and installed on existing tensile-test equipment at the U. S. Army's Watertown (Mass.) Arsenal. A cryostat is a special type of refrigerator and, in this application to tensile testing, it cools specimens of structural materials.

Designed to specifications required in a testing process developed at the arsenal, the ADL tensile-test cryostat has two parts—a cooling chamber and an automatic measuring device. Through the use of liquid nitrogen and liquid helium, the chamber can be refrigerated to −452 F. Two pairs of sliding calipers inside the chamber scan the specimens' dimensional deviations during stress applications and relay measurements to a computer-recorder which plots a stress-strain curve. In tests run to date, the measuring device has been accurate to ±0.001 in.

Low-Temperature Metal Cleaning

A BURN-OFF oven, as everyone in metalworking knows, is a simple, economical method of cleaning sheet-metal parts such as those used for manufacturing domestic oil and gas furnaces. It is hard to beat from an operating-cost standpoint of simply getting rid of grease.

But a switch to a five-stage low-temperature metal-cleaning unit, coupled with a dry-off oven, designed and manufactured for the Columbus, Ohio, division of Lennox Industries by the R. C. Mahon Company's Industrial Equipment Division of Detroit, brought about several improvements: (*a*) It enabled the company to double up processing operations through a single cleaning system, taking care of rustproofing requirements for air-conditioning units (not produced before); (*b*) increased cleaning efficiency permitted getting rid of soot, dirt, and grease; (*c*) operating costs were cut 5 per cent.

The 700-F burn-off oven previously used had high maintenance cost from the replacement of burner tiles, broken by parts dropping on them, and from the action of the heat on the conveyer chain and trolley. Operating costs of the single-purpose system were $4.53 per hr.

In the new Mahon cleaning and rustproofing system, which operates at 90 to 120 F for cleaning, and 400 F for dry-off of parts, no tiles are involved.

Both furnace and air-conditioning parts are being processed by conveyer through the same system, with no increase in floor space, at a little over 10 fpm. The cost of operating the dual-purpose line is $4.46 per hr.

Processing operations were doubled up and cleaning was combined with rustproofing in a new five-stage cleaning machine. Gas burners, at left, are for the dry-off oven.

Materials Briefs

▶ Ceramic-on-Metal Composite

A CERAMIC-ON-METAL composite announced by Pfaudler Division of Pfaudler Permutit Inc., possesses exceptional resistance to high-temperature corrosive vapors which would destroy most metals in a matter of minutes.

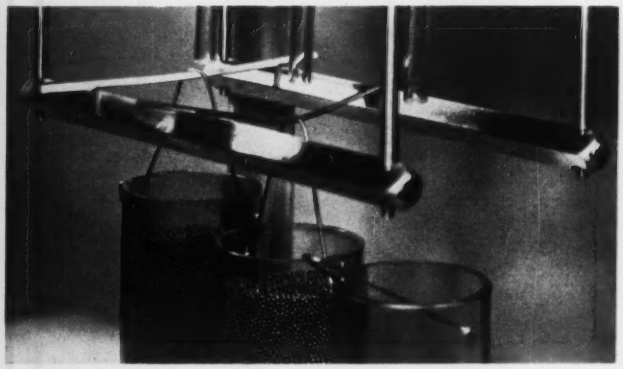
Trade-marked "Nucerite" by Pfaudler, the new material is a unique crystallized glass structure physically and chemically bonded to a structural metal. Except for the ceramic's unusual properties, the structure is comparable to the glassed steel which Pfaudler has been supplying to the chemical industry in the form of tanks, pipes, and other process equipment exposed to corrosive action. With the ceramic, the company reports a significant advance in mechanical strength, impact strength, thermal shock resistance, abrasion resistance, heat conductance, and high-temperature stability.

Nucerite can be permanently bonded to steel or to other heat-resistant materials such as Inconel or Hastelloy. Because of the nature of some anticipated higher-temperature applications to 2500 F, it is also probable that certain of the refractory metals such as tantalum, niobium, and molybdenum—which maintain strength at elevated temperatures—will also serve as base metals.

Although Pfaudler has successfully fabricated the new ceramic-on-metal combination into common items of process equipment such as small reactor vessels and heat-exchanger parts, results were obtained in carefully controlled laboratory and field tests. Nucerite has yet to be transformed from the developmental stage to full-scale production. An extended evaluation period of field testing in the U. S. is planned, to be followed by the establishment of production facilities in all of the Pfaulder Permutit manufacturing plants.

With a thermal shock of 1200 F Δt there is no visible damage to a Nucerite sample which has a 0.020-in. ceramic coating on a 1/4-in. mild-steel plate. Heating to 1200 F was followed with ice water.

Tensile strength of Nucerite was tested by adding lead shot to cylinders suspended from samples of soda-lime glass rod which broke at about 25,000 psi; mild steel bar deformed at 85,000 psi as did Nucerite



Nuclear Briefs

▶ Nuclear Power Raises Ship's Cruising Range 20 Times

EIGHT pressurized-water nuclear reactors will be operated in pairs to supply the power to drive four massive propellers on the aircraft carrier *Enterprise*, the largest ship ever built. Philip N. Ross, Mem. ASME, general manager of the Bettis Atomic Power Laboratory, Pittsburgh, Pa., stated at the christening that: "It is estimated that atomic power will multiply by some 20 times the distance the *Enterprise* can travel at full speed without refueling as compared with the conventional oil-fired carriers. Dependence on far-flung bases and auxiliary ships is thus minimized."

The atomic reactors were developed by Westinghouse Electric Corporation at Bettis, under the direction of and in technical co-operation with the Naval Reactors Branch of the Atomic Energy Commission. The feasibility of harnessing two reactors together for tandem driving of a single propeller shaft at full power has already been proved in the operation of a land-based prototype at the Naval Reactor Facility in Idaho.

The *Enterprise* will be driven by propulsion units manufactured by Westinghouse at its steam division at Lester, Pa. Hydraulically powered 4000-sq-ft Westinghouse elevators (large enough to hold 2000 people and weighing 210,000 lb each) can each lift a 45-ton bomber from hanger to flight deck in 15 sec—one a minute, including loading and unloading. Other equipment being supplied by various Westinghouse divisions includes auxiliary generators and switchgear, motors and control equipment, transformers, and ventilator fans.

▶ Glass for Radiation-Measuring Equipment

A new kind of glass with a radioactivity less than 6 per cent of comparable glasses has been developed by Corning Glass Works for the Atomic Energy Commission. The extraordinarily low radioactivity is required for electronic equipment precise enough for measuring extremely small amounts of radiation.

The glass will be used to make bulbs, headers, and other components of photomultiplier tubes, a vital part of radiation-measuring equipment.

An immediate use of the equipment will be fast and accurate measurement of beta and gamma radiation in human beings, the atmosphere, foods, clothing, shelters, and other objects, whether the radiation comes from fallout or natural sources.

According to the company, the new glass has a radioactivity of less than 10 counts per minute per kilogram. Most glasses in present use have a count of more than 175.

Fused silica, an ultrapure material, has a count of about 10; however, it is difficult to form into bulbs and does

▶Stainless-Steel Automobile Body

A special automobile body to display the long-lasting good appearance of stainless steel and the ease of fabrication and joining of this unusually rugged and corrosion-resistant metal has been made for Allegheny Ludlum Steel Corporation of their own steel. The body of the car is not colored or protected in any way, and will not be protected from the elements although it is expected to "outlive anyone alive today."

The more than 300 stainless-steel parts were frabricated by the Budd Company from regular production-run Type 302 stainless and given a satin-smooth finish. The parts were made near the end of the run for the 1960 Ford Thunderbirds and required over 1000 dies. The body was equipped with a Thunderbird 300-hp 4600-rpm engine. A stainless-steel muffler, grille, and bumpers, made from Type 430 stainless, complete the demonstration of the use of this material.

The company expects to display the new car in auto shows around the country and to interested persons in the automotive and allied fields.

▶ 3000 F Obtained With Pencil-Thin Quartz Lamps

A tubular, pencil-thin quartz infrared lamp, used in closely arrayed banks for overvoltage operation, is creating temperatures of more than 3000 F for thermal-barrier simulation.

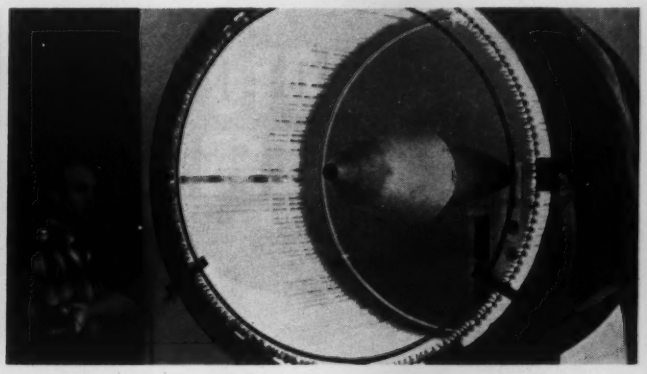
Temperatures in this work must be varied rapidly and controlled accurately which makes the fast heating and cooling characteristics and low thermal capacity of quartz infrared lamps very desirable.

The maximum wattage a quartz lamp can withstand is determined by the melting point of the tungsten filament (about 6100 F).

A new lamp General Electric now has under development is designed to operate at 360 watts per in. but it will be capable of operating at outputs as high as 1500 watts per in. for very short periods.

An unusually rugged and corrosion-resistant demonstration automobile body was made from Type 302 stainless steel. Given a satin-smooth finish it required no enameling or other protective coating.

Heat produced by 225 2500-watt pencil-thin tubular General Electric quartz infrared lamps mounted in a cylindrical radiator produced temperatures of 3100 F to simulate the thermal barrier.



not seal easily to tube bases. The new glass is readily formed and seals well to Dumet, Sylvania No. 4, and similar alloys. Thermal coefficient of expansion of the new glass is stated to be about 95×10^{-7} per deg C.

▶Canada Exports Nuclear Fuel Elements

Canada's first private export sale of nuclear fuel elements will be made to the Japan Atomic Energy Research Institute by AMF Atomics Canada Ltd., of Port Hope, Ontario, a subsidiary of American Machine and Foundry Company. The contract calls for AMF to manufacture 270 natural-uranium fuel elements for use in the JRR-3, a 10-mw heavy-water-moderated research reactor operated by an agency of the Japanese Government.

In commenting on the contract, Morehead Patterson, Mem. ASME, AMF board chairman, said: "This is a significant milestone in the development of industrial participation in Canada's atomic-energy program. We have been devoting a great deal of effort to helping promote world markets for Canadian uranium products because of the country's vast supply of uranium, and we believe that Canada can become a strong competitor with foreign producers of these products." Previous sales of fuel elements to foreign customers have been made through Atomic Energy of Canada Limited, the Canadian Government's atomic-energy organization charged with the development of nuclear energy.

▶Main Features of HTGR Announced

Steam conditions of 1000 F and 1450 psi will be attained on the 40,000-kw High-Temperature Gas-Cooled Reactor to be completed in 1963 at Peach Bottom, Pa. Helium gas cooling will make possible a 1380-F coolant-outlet temperature and a thermal efficiency of about 40 per cent. Novel solid homogeneous graphite-clad fuel-moderator elements will provide a high fuel burnup for each core loading because of the high dilution of the U-235 fuel and fertile thorium 232 by the graphite moderator, and because of the small ratio of parasitic absorbers involved in the reactor's core structure. Core lifetime will be about three years.

The details were given in a paper, "The Application of High-Temperature Gas Cooling to Nuclear Power Plants" presented by Frederic de Hoffmann, senior vice-president of General Dynamics Corporation and president of the General Atomic Division. Dr. de Hoffmann presented the paper at the conference on small and medium-power reactors sponsored by the International Atomic Energy Agency, at Vienna, Austria.

The HTGR is being built by Philadelphia Electric Company, together with 52 other U. S. utility companies which make up High Temperature Reactor Development Associates, Inc. The 53 utilities represent the largest group of companies ever to support a nuclear power project in the United States.

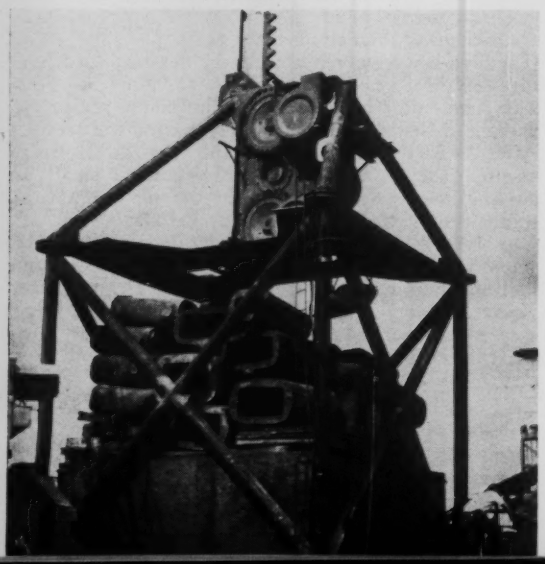
Radiation Detector.
This device, developed at Hughes Aircraft for use in missile flights, will provide a "count" of radiation that would penetrate a spaceman's cabin. Detection element is a thin slice of silicon which emits pulses. Pulses are amplified, then telemetered to earth.

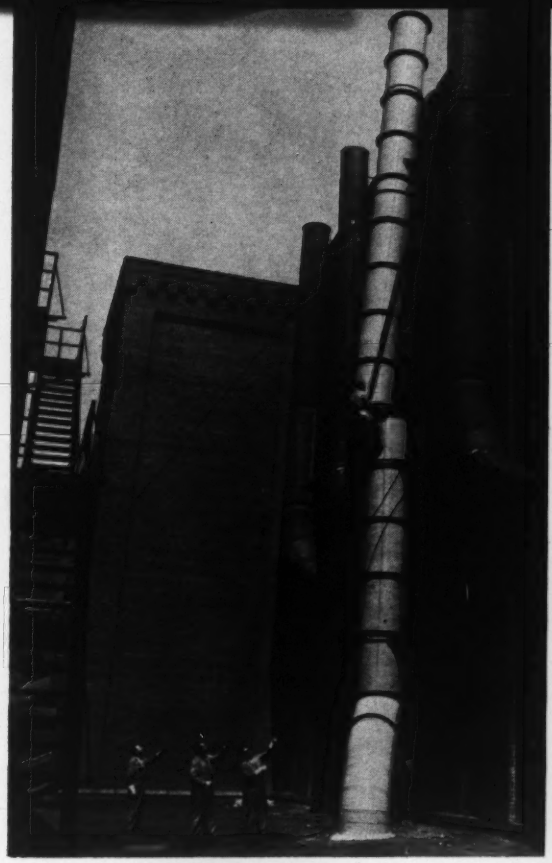
PHOTO BRIEFS

M. BARRANGON

Space Chamber.
Under the supervision of a helicopter and a radio-equipped aide, a 42-ton space-environment chamber is moved into position at Republic Aviation. The $500,000 chamber, built by Tenney Engineering, can test men or full-scale space-ship sections up to 750,000-ft altitude.

Elevator for 1000 tons.
Ultimate purpose of this electric elevator is to raise and lower mobile offshore drilling platforms built by R. G. LeTourneau, Inc. It is shown lifting 2,000,000 lb of steel in tests at their Longview, Texas, plant. LeTourneau makes these elevators in other capacities. This size contains three a-c motors and gear reductions.





Koroseal Exhaust Stack.
Used to exhaust corrosive fumes from an automatic plater, this vinyl stack at B. F. Goodrich in Akron, Ohio, is expected to last 15 years, against 3 or 4 years for metal stacks.
The sections, fabricated by Chamberlin Rubber, Rochester, N.Y., are 36 in. in diam, have $^1/_8$-in. wall thickness.
The stack is 80 ft high.

Multipurpose Package.
This Boeing-designed container replaces a subcontractor's shipping box, an in-plant handling box, and a test stand.
Savings: 50 per cent in handling costs.
(That's a missile auxiliary power unit in the box.) Suppliers were: Shockmount-Lord Manufacturing, Erie, Pa., and Evans Locking Spindle Boxes—Industrial Crating and Packaging, Seattle, Wash.

Lockset With Nylon Mechanism.
This door lock, developed by Lockwood Hardware Manufacturing Company, Fitchburg, Mass., uses du Pont's Zytel nylon resin for all major internal parts.
The nylon locksets are silent, resilient, require no lubrication, cannot rust, and are immune to electrolytic corrosion.

Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

EUROPEAN SURVEY

Water-Turbine Ballast Pump

THE De Laval Ljungstrom Turbine Company, of Stockholm-Nacka, Sweden, have fitted a new type of ballast pump in the tanker *Texaco Iowa*, built by Kockums Mekaniska Verkstads A/B, of Malmö, for the Texas Company, New York, N. Y. It is a vertical-spindle centrifugal pump driven by a single water-turbine wheel, and will deliver 925 gpm at 1500 rpm. The pressure water to drive the turbine is supplied by a Butterworth pump delivering 360 gpm at 170 psig. The unit is suspended submerged about three ft from the bottom of the tank by means of its own piping. The turbine wheel and the pump impeller are mounted on a common shaft and enclosed in a bronze casing. The bearings are water-lubricated by driving water tapped off the main delivery pipe through a bypass in which are a settling tank and a gravity dirt trap. Six months in service have shown that the new pump has a capacity about double that of a normal water ejector used in conjunction with a Butterworth pump and under similar operating conditions.

Hydraulic Tool Clamping

AT THE recent International Machine Tool Exhibition held in London, H. W. Kearns & Co., Ltd., Broadheath, Manchester, England, showed a new horizontal boring, surfacing, milling, drilling, and tapping machine, Model 451P, with a number of novel features.

The cellular bed has a central channel housing the longitudinal screw and its mechanism and forming an oil bath. The $7\frac{1}{2}$-hp driving motor is mounted at the back of the bed and drives by plastic belting to a nine-speed gearbox which, with the three gear changes on the spindle slide gives the machine a total of 27 speeds. A hydraulic tool-clamping and release system is fitted to the nitrided main spindle and is operated by a rotary switch on the main control pendant. To insure accurate and constant effort when holding the No. 40 nonstick mandrels into the spindle nose, the central drawbar is pulled into position by a powerful spring in the end of the main spindle. The spring is overcome by applying hydraulic pressure to a cylinder on the end of the spindle. A bayonet catch holds the mandrel in position. The feed mechanism of the facing slide consists of only three simple components, a large-diam worm, driving twin spiral gears engaging with two racks attached to the facing slide, the whole being automatically lubricated.

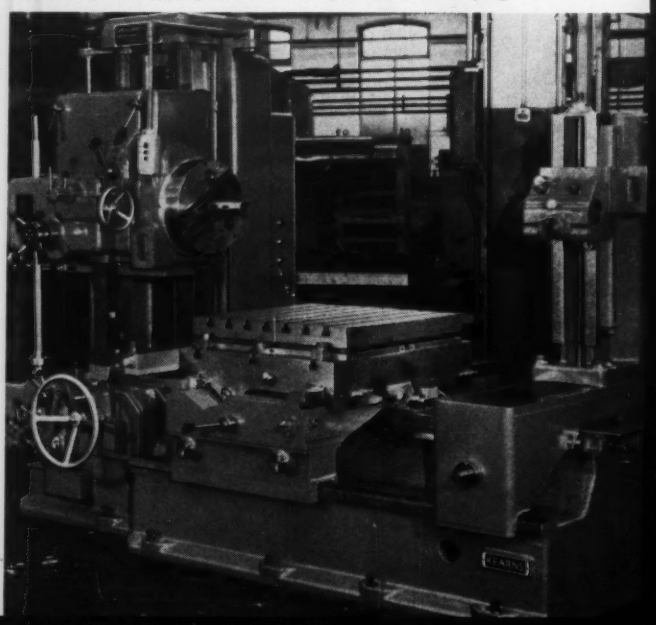
The Kearns "Optimetric" system, which has been described in MECHANICAL ENGINEERING in connection with an earlier machine, permits adjustment of the spindle slide and boring stay bearing, and the transverse movement of the table, to be made to settings of 0.001 in. within limits of ± 0.00025 in. or to 0.01 mm within ± 0.005 mm.

Hydraulic Turbines Symposium

ON THE invitation of the Société Hydrotechnique de France, the International Association for Hydraulic Research held a Symposium on Hydraulic Turbines at Nice, France, from September 16–20. The President of IAHR for 1960–1961, A. T. Ippen, Mem. ASME, of M.I.T., was unable to be present, but James W. Daily, Mem. ASME, of the Hydrodynamics Laboratory, M.I.T., attended in his stead. The 28 papers were grouped under three heads, namely, permanent regime, with and without cavitation; instability of flow, regulation, and transitory regimes; and problems concerning the study, construction, and use of hydraulic turbines. Cavitation bulked largely in both the papers and the discussions. In both there was a marked tendency to treat the subjects from the angle of the research laboratory. The 130 or so participants included representatives of manufacturers

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

Kearns patent optimetric horizontal tool-room surfacing, boring, milling, drilling, and tapping machine with hydraulic tool clamping



and users of large hydraulic turbines. In a general discussion on the final day, it was suggested that a future symposium might consider pumps. One speaker recommended that its coverage should be limited to basic research, as any attempt to include applied research might involve commercial interests.

Contributions to the discussion in writing will continue to be accepted until January 31, 1961, and should be sent to the office of the Local Committee of the Symposium ("Le Comité Local du Symposium A.I.H.R.," to use the French version of the Association's initials) at 12 Place des Etats-Unis, Paris 16e, France.

Britain's First "Travolator"

THE Southern Region of British Railways has the biggest electrified suburban system in the world and a great part of its morning and evening traffic of City commuters is handled through Waterloo Station. But Waterloo is on the south bank of the River Thames and a mile away from the center of the city on the north bank, so, 62 years ago, a direct electric subway line was driven under the river, terminating close to the Bank of England. To get to street level at the Bank, however, the passengers had to walk up a tunnel 340 ft long and only 13 ft wide (popularly or unpopularly known to Londoners as "the Drain") with a gradient of 1 in 14. In the past 20 years the peak-hour load has practically doubled. A scheme for a long escalator was prepared in 1939, but the war stopped this, and when it was taken up again a different plan was adopted—to install in a new tunnel two "Travolators," designed and built by the Otis Elevator Company, Falmouth Street, London. After three years of difficult underground engineering and the expenditure of some $23 million, they have now been brought into service.

The two Travolators, though similar in principle to the American "speedwalks," are the first of their particular kind in the world. Each consists of 488 individual platforms, 40 in. by 16., surfaced with aluminum. Each platform is carried on four ball-bearing wheels of canvas, impregnated with phenolic resin, and running on steel tracks mounted on concrete blocks. The platforms are connected together and driven by two roller chains that are made to very fine tolerances and assembled in matched lengths; thus the platforms are held firmly in their relative positions and their surfaces form in effect a continuous conveyer belt. They are designed for a working load of 300 lb over each 4.45 sq ft of the area exposed to passenger loading. At the maximum speed of 180 fpm, each can carry 10,000 persons an hour up the incline, which is 1 in 7. The vertical rise is 42 ft and the over-all length, including the horizontal portions at the top and bottom landings, is 302 ft. The speed can be reduced down to 90 fpm in normal use, and there is also a speed of 36 fpm for adjusting purposes. To save wear during off-peak periods, a selenium cell cuts the travel strip speed to 90 fpm when no passengers have been carried for a predetermined time.

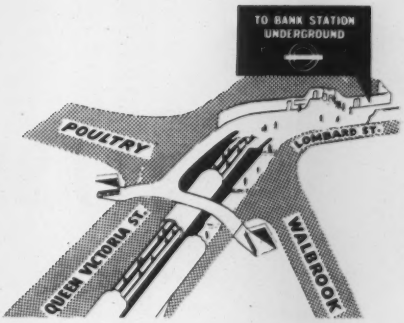


Diagram of Travolators showing entrances at Bank of England

The drive is from a variable-speed three-phase commutator motor of 85 hp, connected by a large coupling to a worm gear. The coupling forms the drum of an electromagnetic brake, spring-applied and magnetically released. Each Travolator has its own automatic magnet-operated control gear and can be run in either direction. During the rush hours, both will run in the same direction—Cityward in the morning and outward in the evening; passengers wanting to go the other way will then do so on foot through the old tunnel, which is parallel with the new one. Up-Down buttons are provided for local control at top and bottom, and there are five emergency switches on the balustrade between the tracks. The installation of the Travolators has enabled the interval between trains to be cut from 3 to $2^1/_2$ min, so that an additional 17 rush-hour trains per day can be run.

View from the platform level of the 302-ft-long Travolator now in operation transporting subway passengers to street level at the Bank of England in London. It was officially opened September 27 by the Rt. Hon. The Lord Mayor of London. Construction began October, 1959.

Substance in Brief of Papers Presented at ASME Meetings

ASME TECHNICAL DIGEST

Heat Transfer

A Survey of P-V-T Data for Water in the Critical Region..60—HT-25... By E. S. Nowak; R. J. Grosh, Assoc. Mem. ASME; and P. E. Liley, Purdue University, Lafayette, Ind. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

A comprehensive review is given of P-V-T data available for water at pressures from 2700 to 4000 psia, specific volumes from 0.025 to 0.125 cu ft per lb, and temperatures from about 630 to 800 deg F.

The paper is divided into four sections dealing consecutively with saturation, subcooled liquid, and superheated-vapor data, and finally with the observations and conclusions of various investigators on the critical point. Usually, experimental data, computed values, and the constants in various formulations have been converted into English units.

The results indicate there is a lack of smoothed or computed values for the specific volumes of the superheated vapor at sufficiently close intervals in the critical region. This makes it difficult to interpolate accurately and derive such properties as density and coefficients of volume expansion and compressibility. Furthermore, there are significant differences between the data for superheated steam given in the various tables which can be attributed to erroneous methods of interpolating the original experimental data.

Smoothed Pressure - Volume - Temperature Data for Water in the Critical Region Derived From Experimental Measurements..60—HT-26... By E. S. Nowak; R. J. Grosh, Assoc. Mem. ASME; and P. E. Liley, Purdue University, Lafayette, Ind. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

A graphical technique was used to derive pressure-volume-temperature data from previous American, Czechoslovakian, and Russian experimental measurements. The data were derived at close intervals throughout the region encompassed by pressures from 3000 to 4000 psia, specific volumes from 0.030 to 0.120 cu ft per lb, and temperatures from 690 to 752 F.

The average deviation of experimental values of pressure from the derived values was less than one part in 10,000 in the region for specific volumes greater than the critical volume (0.0525 cu ft per lb) and was less than ten parts per 10,000 in the region for specific volumes less than the critical volume. These deviations are thought to be insignificant since they are entirely within the uncertainty of recent experimental measurements.

In a previous paper, "A Survey of P-V-T Data for Water in the Critical Region," by the same authors, deviations of some 100 to 200 parts in 10,000 in pressure were shown to exist between the data of various steam tables. Since the data in the steam tables were derived from the same primary data used in this paper, one may conclude that these deviations greatly exceed the experimental uncertainty and must therefore be charged to previous interpolation methods and the previous paucity of data.

One of the important results of this study was the establishment of the fact that there was excellent agreement between recent measurements by Kirillin and others, and older measurements by Keyes and Smith and by Havlicek and Miskovsky.

Transient Natural Convection From Vertical Elements..60—HT-33... By B. Gebhart, Assoc. Mem. ASME, Cornell University, Ithaca, N. Y. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

The transient natural-convection process occurs when a vertical element, immersed in an extensive fluid bath initially is subjected to energy-dissipation (or absorption) internal to the element material. This process is analyzed using an integral method of analysis. Differential equations are derived which relate average surface temperature and time for either heating or cooling for vertical elements having arbitrary thermal capacity. The equations are applicable to laminar flow for all fluids. The coefficients are Prandtl-number dependent and are estimated for Prandtl numbers in the range of 0.01 to 1000.

A solution of the equations is presented for the extreme case of a vertical plate of negligible thermal capacity subjected to a step in flux at its surface. Fluids having Prandtl numbers of 0.01, 0.1, 0.72, 1.0, 5, 10, 100, and 1000 are considered. The results, in terms of generalized variables, are practically independent of Prandtl number.

Simple one-dimensional transient behavior is followed for approximately 20 per cent of the transient with a subsequent quick approach to the asymptotic value. The results show no substantial overshoot of the average surface temperature. It is doubted that significant temperature overshoot actually occurs for vertical surfaces even for a step in flux.

The Influence of Sound on Free Convection From a Horizontal Cylinder..60—HT-14... By R. M. Fand; and J. Kaye, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

The authors previously have described a new type of acoustic streaming, called thermoacoustic streaming, which occurs near a heated horizontal cylinder in the presence of horizontal transverse sound fields. In the present paper, quantitative experimental results are presented, which show that thermoacoustic streaming causes a marked increase in the coefficient of heat transfer from a heated cylinder; for a given temperature potential, the

superposition of a sound field can increase the heat-transfer coefficient by a factor of 3, relative to the free-convection heat-transfer coefficient in the absence of sound. An empirical equation is provided by means of which the coefficient of heat transfer from a horizontal cylinder in the presence of horizontal transverse sound fields can be computed for many cases of practical interest.

An Experimental Study of the Effects of Strong Progressive Sound Fields on Free-Convection Heat Transfer From a Horizontal Cylinder..60—HT-19... By A. L. Sprott, ARDC, Los Angeles, Calif.; J. P. Holman, Assoc. Mem. ASME, Southern Methodist University, Dallas, Texas; and F. L. Durand, Wright Air Development Division, Wright Patterson Air Force Base, Ohio. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; available to June 1, 1961).

It is demonstrated experimentally that strong progressive sound fields may interact with a free-convection boundary layer on a horizontal cylinder in such a manner as to produce increases in heat-transfer rates of the order of 100 per cent.

Shadowgraph flow-visualization studies indicate that the mechanism of the interaction is such that a separated flow region on the upper side of the cylinder is produced. No effect on the boundary layer or heat transfer is observed until the sound intensity is raised above a certain critical value. For the experiments described in the paper, the critical sound pressure level ranged from 134 to 138 decibels.

In a qualitative analysis of the experimental results it is postulated that the increase in heat transfer is the result of an interaction of the phenomenon of acoustical streaming with the free-convection boundary layer.

Hydraulic Instability in a Natural Circulation Loop With Net Stream Generation at 1000 Psia..60—HT-27... By S. Levy, Assoc. Mem. ASME, and E. S. Beckjord, General Electric Company, San Jose, Calif. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; available to June 1, 1961).

In a closed-loop system, natural circulation flow is set up whenever a density-head difference exists between the two vertical "legs" of the loop. Under steady-state conditions, the circulation rate is such that the available density head equals the friction, acceleration, and other pressure losses in the flow circuit. Changes in power input, pressure, geometry, temperature, and flow rates upset this state of equilibrium; but most often the system readjusts itself to another stable operating point. However, under certain conditions, disturbances from the equilibrium state can be propagated and amplified with time and the loop becomes unstable.

Recently, experimental test loops have been used to study the problems of hydraulic stability.

The performance of a natural-circulation loop was studied at 1000 psia. Pressure drop, flow, and heater temperature transient oscillations were recorded for all test runs. The test results reveal: (*a*) Instability occurs at lower steam qualities and higher flows as the inlet subcooling is increased. (*b*) An increase in the flow area of the test section gave instability at lower exit qualities and power densities per unit volume of coolant. (*c*) Operation with a downcomer restriction damped the system oscillations, but the maximum achieved power densities prior to burnout were relatively unchanged. (*d*) The burnout heat flux is lower than values reported with forced circulation. (*e*) Frequency of the oscillations varied from 2 to 4 sec.

The test data were compared with predictions from three analytical models. They are based upon "negative resistance," "static head," and "flow pattern" instability. None of the models is presently adequate for a complete understanding of the test data. A combination of the last two shows the most promise of success.

Burnout in Turbulent Flow—A Droplet Diffusion Model..60—HT-34... By K. Goldmann, Assoc. Mem. ASME and H. Firstenberg, Nuclear Development Corporation of America, White Plains, N. Y.; and C. Lombardi, Centro Informazioni Studi Esperienze, Milan, Italy. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

Burnout presents one of the principal limitations in the design of liquid or wet steam-cooled nuclear reactors, rocket nozzles, and other high-specific-power equipment.

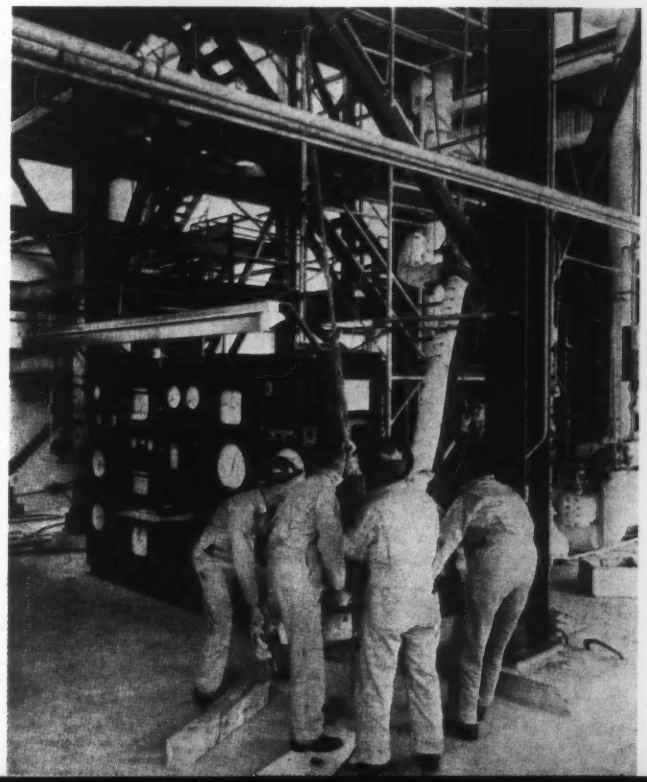
Although the subject of burnout has received considerable attention during the past decade, today's knowledge is not sufficient to predict it with the desired degree of accuracy.

Analytic methods for predicting burnout have utilized physical models that have generally been based on visual observations of pool boiling, and as such, correlate pool-boiling data quite well. But they fail for flowing systems.

It is suggested in the present paper that the controlling mechanism for burnout in flowing systems, particularly at high Reynolds numbers, is not to be found in bubble behavior but rather in the eddy diffusion-limited transport of liquid droplets through a steam boundary layer to the heated wall. This concept appears particularly attractive for fog flow, but may also be applicable to flowing low-quality steam and even subcooled liquid systems.

Two-phase flow regimes are briefly reviewed, a burnout model is described, basic equations for burnout in fog flow are derived and a preliminary comparison is made between analysis and the results from experiments in the fog-flow regime.

The heat-transfer test facility. It is comprised of two stainless-steel loops into which are inserted flanged pipe sections containing the electrically heated test sections. A control panel is adjacent to the loops (60—HT-27).



Heat Transfer to Water in Turbulent Flow in Internally Heated Annuli Part 1—Stationary Flow..60—HT-20... By Z. Rotem and I. Shai, Technion—Israel Institute of Technology, Haifa, Israel. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; available to June 1, 1961).

While engaged in heat-transfer investigations of pulsating flow in annuli, the authors came to the conclusion that some data previously published on that subject were open to criticism as a careful correlation for the stationary-flow case had not been obtained with the same experimental installation. A careful investigation was therefore undertaken.

Values of local heat-transfer coefficients in turbulent flow of water through a circular concentric annular duct were obtained. The outside to inside diameter ratio used was 1.593. Uniform core-wall heat flux was used, with very low fluid temperature rise, to reduce longitudinal conduction and to approximate the constant wall-temperature case. A total of 450 points was taken. A Colburn type of correlation was obtained, and compared with other correlations.

Heat Transfer to Water in Turbulent Flow in Internally Heated Annuli Part 2—Pulsating Flow..60—HT-21... By Z. Rotem and I. Shai, Technion—Israel Institute of Technology, Haifa, Israel. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; available to June 1, 1961).

Measurements of pulsating flow heat transfer were undertaken on an annular duct with a heated core tube. The test installation was first checked carefully to give reasonable correlation with published data on stationary flow heat transfer in circular, concentric annuli. A total of 33 series of test runs (165 points) was then taken with pulsating flow. Within the range of frequencies and pulsation ratios tested, no significant change in heat-transfer coefficients was obtained.

The Effect of Density Variation on Heat Transfer in the Critical Region..60—HT-8 ...By Yih-Yun Hsu, NASA Laboratory, Cleveland, Ohio; and J. M. Smith, Northwestern University, Evanston, Ill. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

The heat-transfer coefficient between fluid and tube wall in turbulent flow depends upon the physical and thermal properties of the fluid. When density changes across the diameter of the tube are large (for example, when the fluid is near the critical point), the variable density can affect the transfer of momentum and heat. Equations are developed for predicting the magnitude of this effect on the heat-transfer coefficient. Deissler's expressions for the eddy diffusivity are employed in solving the equations for heat and momentum transfer.

For flow in vertical tubes large density variations can also affect the heat transfer by inducing natural convection. By considering the influence of body forces on the shear stress, equations are derived to predict the effect of natural convection on the heat-transfer coefficient for turbulent flow. The results indicate that the effect is significant only for relatively high Grashof numbers and low Reynolds numbers. Such conditions may be encountered in flow of a fluid near its thermodynamic critical point.

The derived equations are applied for carbon dioxide flow in the critical region under the conditions for which experimental data were measured by Bringer and Smith. Because of the high Reynolds and low Grashof numbers, natural convention is not significant. However, the effect of the large density variations is found to be significant, and the predicted results agree well with the experimental data.

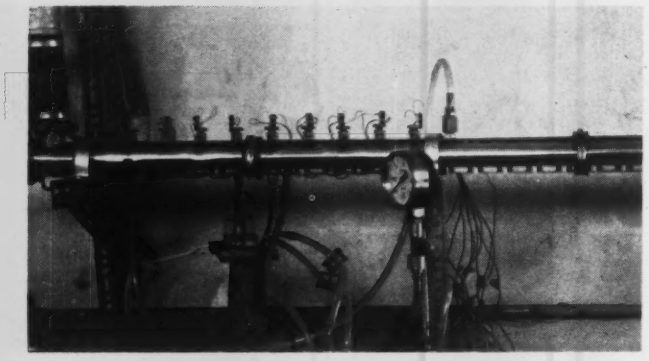
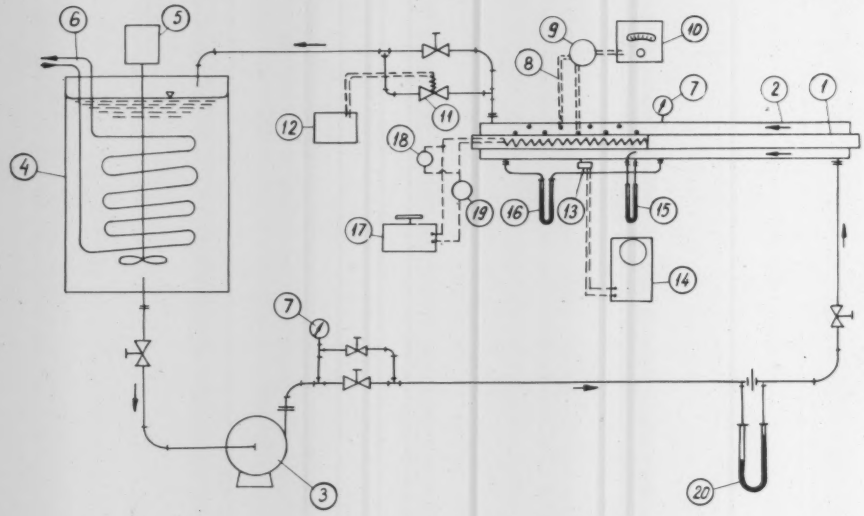


Diagram of test apparatus for measuring pulsating flow heat transfer on an annular duct with a heated core tube, **below** (60—HT-21). **Above** is a view of the tube and pressure gage (60—HT-20).



Key to diagram, **left**

1 Inner tube (brass)
2 Outer tube (perspex)
3 Water pump
4 Cooling tank
5 Mixer
6 Cooling coil
7 Pressure gage
8 Thermocouple
9 Thermocouple switch
10 Potentiometer
11 Solenoid valve
12 Multivibrator
13 Pressure transducer
14 Oscilloscope
15 Pitot tube
16 Manometer tube
17 Input transformer
18 Voltmeter
19 Ammeter
20 Calibrated orifice and manometer tube

Heat Transfer by a Turbulently Flowing Fluid-Solids Mixture in a Pipe..60—HT-23... By C. L. Tien, University of California, Berkeley, Calif. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

Analysis is made on the heat transfer by a turbulently flowing fluid with suspended small solid particles in a circular pipe. Temperatures in the system are assumed to be less than about 1000 F, so that radiation effects are negligible. The loading ratio of solids to gas based on mass is less than or equal to one in the present investigation.

The governing equations for the system are derived as two coupled linear equations. With approximations, the governing equations with their boundary conditions reduce to a form of the corresponding governing equation for the one-phase heat-transfer system. Computations of the solution are accomplished by use of the solutions in one-phase case. The final results are compared with existing experimental data.

Radiant Heat-Transfer Analysis of a Furnace or Other Combustion Enclosure.. 60—HT-12... By J. T. Bevans, Mem. ASME, Shell Development Company, Emeryville, Calif. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

Radiation exchange within a combustion enclosure was recently examined in general terms in the paper "Radiant Interchange Within an Enclosure: Part 2," by R. V. Dunkle and J. T. Bevans. The method presented here is an application of certain features of this study, as well as an extension of it.

This method permits a more complete analysis of the radiation heat transfer using some of the physical simplicity of the method of Lobo and Evans, but with less difficulty than the methods of either Hottel or Oppenheim. The problem is reduced to the solution of M-P simultaneous algebraic equations.

The physical dimensions of the enclosure are assumed to be specified and composed of M surfaces. The extent and specification of a surface is not restricted; a surface may be a fraction of the length of a process tube, a whole tube bank, one segment of a wall of the enclosure, or all of the walls. The number of surfaces and the subdivisions used are a compromise between the detailed knowledge desired and the length of the computations.

The variables considered are the heat flux and the temperature of each surface; these are assumed to be uniform over a surface.

The method is compared with other analyses.

Radiation Heat Transfer in a Spherical Enclosure Containing a Participating, Heat-Generating Gas..60—HT-9... By E. M. Sparrow, Assoc. Mem. ASME, University of Minnesota, Minneapolis, Minn.; C. M. Usiskin, and H. A. Hubbard, NASA, Lewis Research Center, Cleveland, Ohio. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

The analytical formulation of problems involving certain idealized gas properties and simple geometries are useful in gaining an understanding of the more complex design problems involving radiation heat transfer through gases.

An analysis is made of the thermal radiation in an absorbing-emitting nonisothermal gas confined in a hollow spherical enclosure or in the space between two concentric spheres. The gas is gray and contains a volume heat source, while the bounding walls are black and isothermal. The conservation of energy principle yields an integral equation which has been solved for a wide range of geometric and radiative conditions. It is found that as the absorption coefficient increases in a fixed geometry, the gas temperature decreases and becomes more nonuniform. On the other hand, as the enclosure size increases, the gas temperature increases and becomes more nonuniform. An approximate analysis using a conduction-type transfer law is carried out, and the results are compared with the integral equation solutions.

Analysis, Results, and Interpretation for Radiation Between Some Simply Arranged Gray Surfaces..60—HT-4... By E. M. Sparrow, Assoc. Mem. ASME, University of Minnesota, Minneapolis, Minn.; J. L. Gregg, Assoc. Mem. ASME, J. V. Szel, and P. Manos, NASA, Lewis Research Center, Cleveland, Ohio. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

A detailed analysis has been made to obtain both physical insight and numerical results for radiation between gray surfaces. In particular, it was desired to examine the common assumption that the incident radiation is uniformly distributed over a surface. To lift this assumption, the radiation problem must be formulated in terms of integral equations.

The study was carried out for two simple configurations: Two plates sharing a common edge, and two parallel plates. Solutions of the governing integral equations were found for a wide range of geometric and radiative conditions. A detailed interpretation is made of the results, and comparisons with the predictions from the simplified theory of uniform incident radiation are presented.

Heat Transfer and Pressure Drop in an Annular Gap With Surface Spoilers.. 60—HT-15... By G. A. Kemeny, Mem. ASME, and J. A. Cyphers, Westinghouse Research Laboratories, Pittsburgh, Pa. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME —J. Heat Transfer;** available to June 1, 1961).

Surface spoilers are repeated alterations of a wetted surface configuration deliberately introduced in an attempt to increase turbulent, forced-convection heat transfer to or from the wetted surface.

Heat-transfer and pressure drop data are presented for turbulent water flow in the annular space between concentric tubes. Heat was transferred to the liquid from the inner surface which was equipped with various surface spoiler configurations. A common outer tube was used which was maintained smooth and adiabatic for all tests.

An empirical formula is given which correlates friction factors for circular tubes and annular gaps, or narrow flat passages, with semicircular spoilers on either one or both sides. The use of such friction factors in the Martinelli equation for turbulent heat transfer gives satisfactory estimates of the heat transfer for spoiler configurations.

Radiative Transport Within an Ablating Body..60—HT-2... By Leo P. Kadanoff, Avco-Everett Research Laboratory, Everett, Mass. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

The emission and reabsorption of thermal radiation within a semitransparent material provides a mechanism that supplements ordinary thermal conduction in transporting energy from hotter to colder regions. A method has been developed for the calculation of net radiative flux and temperature distribution within a semi-infinite body that emits, absorbs, and scatters this radiation and allows some radiation to escape from its surface.

This method has been applied to the problem of calculating temperature distributions within bodies in steady-state ablation. The bodies are characterized by their refractive index, surface reflectivity, absorption and scattering coefficient, ablation velocity, and surface temperature as well as by their heat capacity and thermal conductivity. Numerical results are presented for the temperature distribution with various values of these parameters. As a result of this analysis, simple formulas are presented for the temperature distribubution very near the surface of an ablating body that are particularly useful in predicting the temperature distribution in the "liquid layer" of a glassy ablating

body. These simple formulas are presented for two limiting cases: Case I, in which the liquid layer is so thin that it is almost completely transparent to radiation, and Case II, in which the radiation mean free path is so short that radiative transport can be completely neglected in determining the temperature distribution in the liquid layer. Also resulting from this numerical analysis is a simple relation between the ablation rate and the emissive power of a body in steady-state ablation.

The concept of effective conductivity is extended to scattering media. It is noted that this concept fails whenever the temperature or optical properties of the medium change appreciably within one radiation mean free path. In particular, the optical properties change discontinuously at any boundary. Thus, in general, the effective conductivity concept fails near a boundary and results in completely wrong answers for the temperature distribution in the liquid layer.

Heat Transfer to Laminar Flow Across a Flat Plate With a Nonsteady Surface Temperature..60—HT-7... By R. D. Cess, Assoc. Mem. ASME, Westinghouse Research Laboratories, Pittsburgh, Pa. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

Forced-convection heat transfer is considered with the purpose of determining the entire time-history of the process for laminar flow across a flat plate whose surface temperature varies with time.

The case analyzed first is that of a step change in surface temperature, and series solutions are obtained that apply for both small and large time. These series results are used to construct an approximate solution that describes the entire time-history of the nonsteady heat-transfer process, and it is found that the results agree closely with an envelope composed of pure transient conduction and steady-state convection solutions. The analysis is then generalized to include any prescribed variation of surface temperature with time.

Film Cooling With Multiple Slots and Louvers..60—HT-35... By J. H. Chin, L. E. Hayes, S. C. Skirvin, Assoc. Mem. ASME, and G. Burggraf, General Electric Company, Cincinnati, Ohio. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

Film cooling is used in many fields to protect structural surfaces from a high-temperature stream. Some applications are in furnaces of the steel industry and in turbojet combustor and afterburner liners.

Experimental results are presented here for film cooling of an adiabatic plate downstream of one to ten slots (Part 1) and two to twenty rows of discrete punched louvers (Part 2) in a subsonic turbulent flow under zero pressure gradient. The adiabatic wall temperatures downstream of the last equivalent slot are measured and correlated in terms of the flow parameters, equivalent slot number and slot spacing, and distances downstream of the last equivalent slot.

Velocity Distributions, Temperature Distributions, Effectiveness and Heat Transfer for Air Injected Through a Tangential Slot Into a Turbulent Boundary Layer..60—HT-31... By J. P. Hartnett, Mem. ASME, Richard C. Birkebak, and E. R. G. Eckert, Mem. ASME, University of Minnesota, Minneapolis, Minn. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

A promising method for protecting a surface exposed to a high-temperature environment involves the introduction of a coolant liquid or gas through discrete slots appropriately positioned along the surface as shown in Fig. 1. This cooling scheme, commonly called film cooling, has already found application in gas turbines and rocket nozzles and in the future may be of value in cooling leading edges of hypersonic aircraft.

A detailed study of the heat transfer for tangential air injection through a single slot into a turbulent boundary layer on a flat plate is presented; the results apply to a specific slot size, one injection rate, and a fixed free stream velocity. Boundary-layer velocity and temperature profiles for a number of positions downstream from the point of injection are presented as well as plate temperature distribution and heat-transfer data for adiabatic and constant heat input wall boundary conditions.

Two-Phase Slug Flow..60—HT-28... By Peter Griffith, Assoc. Mem. ASME, and Graham B. Wallis, Massachusetts Institute of Technology, Cambridge, Mass. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

When two phases flow concurrently in a pipe, they can distribute themselves in a number of different configurations. Slug flow is characterized by large bubbles that almost fill the tube and are separated by slugs of liquid. Such bubbles have rounded noses and, generally, flat tails.

An expression is developed for the mean density in terms of the pipe area, the bubble rise velocity, and the flow rates of the two phases. Observations of bubble shape, length, and velocity are described, and a comparison of computed and measured densities is given. Finally, a method for predicting the pressure drop is presented, and the prediction is compared with experimental results.

Forced-Convection Heat Transfer From an Isothermal Sphere to Water..60—HT-5... By G. C. Vliet, Student Mem. ASME, and G. Leppert, Mem. ASME, Stanford University, Stanford, Calif. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

Heat transfer from a spherical heating element by forced convection occurs in many situations of practical importance. While the present investigation stems from interest in spherical fuel elements for liquid-cooled nuclear reactors, similar heat-transfer conditions may prevail in chemical process reactors and in other engineering applications.

Previously reported measurements of convective heat-transfer coefficients from spheres to liquids have been limited to low Reynolds numbers and to negligibly small temperature differences. This paper correlates these earlier data with new measurements taken at much higher Reynolds numbers and with substantial temperature difference between the heating surface and the liquid. The significance of the larger temperature difference is twofold: Since the viscosity variation of liquids with temperature is usually strong, there may be an important viscosity change across the boundary layer. Furthermore, natural convection effects may not be ignored in regions of large temperature difference and low or moderate Reynolds number. Both of these effects are discussed in the paper.

Natural-Circulation Tests With Water at 800 to 2000 Psia Under Nonboiling, Local Boiling, and Bulk Boiling Conditions..60—HT-36... By O. J. Mendler; A. S. Rathbun, Assoc. Mem. ASME; N. E. Van Huff; and A. Weiss, Assoc. Mem. ASME, Bettis Atomic Power Laboratory, Westinghouse Electric Corp., Pittsburgh, Pa. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

Natural and forced-circulation test data for a closed-loop system are presented and analyzed. The data were obtained at pressures of 800, 1200, 1600, and 2000 psia from the natural-circulation loop at the Bettis Laboratory, using single rectangular channel test sections (0.100 in. × 1.0 in. × 27.0 in. long, 0.200 in. × 1.0 in. × 27.0 in. long, and 0.250 in. × 1.0 in. × 27.0 in. long). Heat fluxes ranged from 50,000 Btu/hr-sq ft to burnout with inlet subcoolings of 20, 70, and 100 deg F.

The results showed that single and two-phase pressure drop, burnout heat flux, and riser density measured under natural-circulation operation are no different from those measured with forced circulation at the same thermal and fluid flow conditions. For the loop studied, it was shown that natural-circulation-loop flow rates can be predicted to within 10 per cent for both single and two-phase flow. Some data for slip ratios at liquid velocities less than $^1/_2$ fps and for two-phase exit losses were obtained. Flow fluctuations were noted during some of the natural-circulation runs; these occurred before burnout heat flux was reached. In some instances these fluctuations were severe enough to cause a premature burnout.

Pool Boiling in an Accelerating System..60—HT-22... By J. A. Clark, Assoc. Mem. ASME, and Herman Merte, Jr., University of Michigan, Ann Arbor, Mich. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

The influence of a force field on pool-boiling heat transfer, as shown in the results of an initial study, are presented.

A force field was utilized that produced accelerations normal to a heated surface in the range 1 to 21 times standard gravity. Although system acceleration different from that due to gravity is not commonly encountered in boiling processes, its role is important as it is the source of the natural convective movement in fluids. With the various new problems encountered in space technology it may be expected that boiling heat transfer will occur in force fields different from that found on earth.

Heat-flux rate was varied from approximately 5000 Btu/hr sq ft (nonboiling) to 100,000 Btu/hr sq ft. Data are presented for the influence of subcooling with the boiling system under acceleration at the lower values of heat flux. A preliminary analysis is presented for a theoretical description of the process of boiling under the influence of high acceleration, including the simultaneous effect of natural convection.

Shell-and-Tube Heat Exchangers: Effect of By-Pass and Clearance Streams on the Main Stream Temperature..60—HT-16... By Byron E. Short, Mem. ASME, University of Texas, Austin, Texas. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; available to June 1, 1961).

Tubular exchangers consist of baffled tube bundles in shells and the tubes are usually arranged in symmetrical patterns. A space usually exists between the tubes and the shell. This space has heat-transfer surface (tubes) on one side and the shell on the other. The fluid stream flowing through this space will have heat transferred to or from it on one side and none transferred on the opposite side.

Most exchangers are of such a size that the tube bundle is assembled outside the shell and the assembly then placed in the shell. To permit external assembly or the removal of the bundle after use, the baffles must have clearance between them and the shell. This removal need also requires that greater space exist between the tubes and the shell than would be required if the bundle were not removable. The space between the tubes and the shell is referred to as "by-pass" space because the fluid that flows through this space misses the major part of the heat-transfer surface of the bundle. The fluid flowing through the baffle-to-shell clearance space also misses the heat-transfer surface but the space, in this instance, is called "clearance" space to distinguish it from the other space.

Ideally, the clearance and by-pass streams in a shell-and-tube heat exchanger are not in contact with heat-transfer surface as is the main stream, which flows over and around the tubes. Consequently, the temperature of these two streams decreases or increases only as a result of the fluid that flows from the main stream because of viscosity changes and mixes with each of the other two streams. The temperature of the main stream at the exit of the exchanger is quite different from the mixed mean temperature of the fluid leaving the exchanger. As a result, the heat-transfer coefficient and the pressure drop computed for the exchanger on the basis of the mixed mean-temperature condition are quite different from the true values especially in the laminar-flow region.

An Experimental Study of Boiling in Reduced and Zero Gravity Fields..60—HT-10... By C. M. Usiskin, Radio Corp. of America, Astro-Electronic Products Division, Princeton, N. J.; and R. Siegel, Assoc. Mem. ASME, NASA, Lewis Research Center, Cleveland, Ohio. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

One of the most important environmental changes man encounters as he leaves the earth is the change in the gravity field. In free space or in an orbiting satellite the gravitational field may closely approach zero. On the surface of the moon or the inner planets of our solar system, the gravitational field is less than that on earth. Heat-transfer processes such as free convection, condensation, and boiling depend on the gravitational body force, and hence will

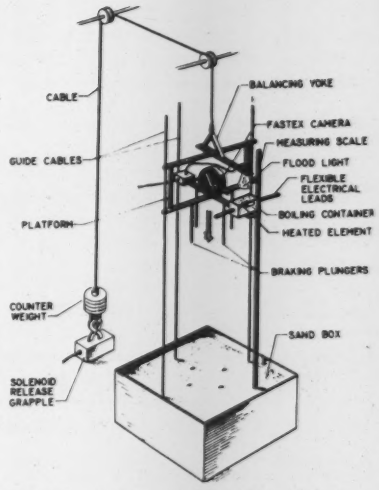


Diagram of the counterweighted platform used in an experimental study of boiling in reduced and zero-gravity fields (60—HT-10)

be affected by this new environment.

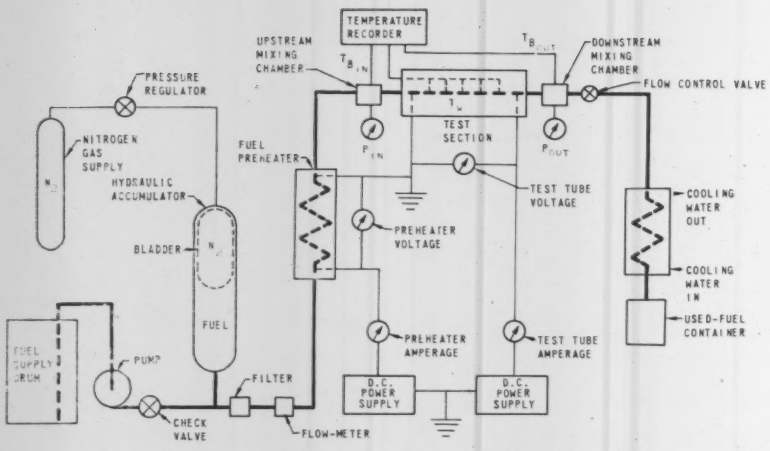
The goal of the present work is to provide quantitative information on how reducing the gravity field affects boiling heat transfer and bubble dynamics.

A pool boiling apparatus was mounted on a counterweighted platform that could be dropped a distance of nine feet. By varying the size of the counterweight, the effective gravity field on the equipment was adjusted between zero and unity. A study of boiling burnout in water indicated that a variation in the critical heat flux according to the one quarter power of gravity was reasonable. A consideration of the transient burnout process was necessary in order to properly interpret the data. A photographic study of nucleate boiling showed how the velocity of freely rising vapor bubbles decreased as gravity was reduced. The bubble diameters at the time of breakoff from the heated surface were found to vary inversely as gravity to the 1/3.5 power. Motion pictures were taken to illustrate both nucleate and film boiling in the low gravity range.

Measured Variations in Local Surface Temperatures in Pool Boiling of Water..60—HT-32... By S. T. Hsu, Mem. ASME, and F. W. Schmidt, University of Wisconsin, Madison, Wis. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

Several different types of boiling occur in boiling heat transfer. Nucleate boiling, in which bubbles form on the heating surface, is by far the most desirable type for high heat-transfer rates.

To obtain an idea of the temperature



A simplified schematic diagram of the test setup for investigating the suitability of JP-4 fuel for the regenerative cooling of a hypersonic ramjet engine (60—HT-18)

variation present during the boiling process and to determine the factors that affect these variations, an investigation of the surface-temperature variation during nucleate pool boiling at atmospheric pressure was conducted.

The problem was analyzed in a series of steps, each one representing a certain bubble size. In the analysis, only one bubble was considered. It was apparent that other bubbles adjacent to it had some influence on the surface-temperature variation. As the bubble density increased, the temperature of the surface was expected to increase because of the increased resistance to heat flow. A temperature pattern, on and below the specimen surface, resulted, and changed as the bubble grew larger.

Through analysis, the effect of the heating-surface material, the finish of the heating surface, and the heat flux of the surface temperature and its variations were determined.

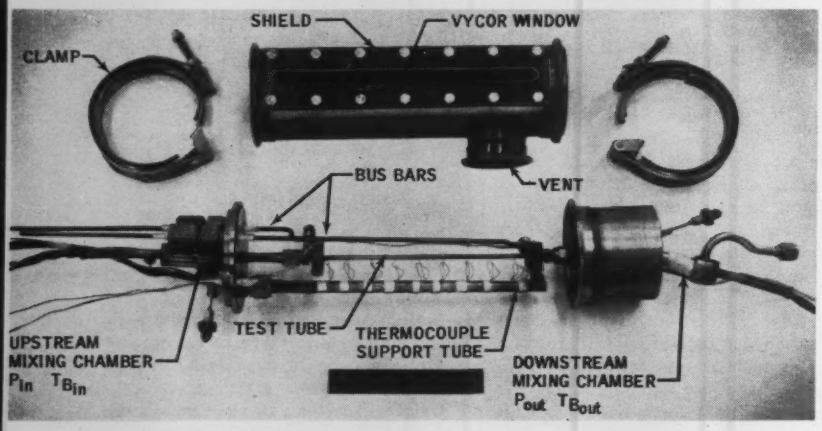
An Experimental Investigation of the Suitability of JP-4 Fuel for the Regenerative Cooling of a Hypersonic Ramjet Engine..60—HT-18...By Richard A. Dutton, Assoc. Mem. ASME, The Marquardt Corporation, Van Nuys, Calif. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; available to June 1, 1961).

During the design of a hypersonic ramjet engine, it was necessary to determine the feasibility of cooling critical areas in the combustion chamber and nozzle by circulation of fuel through passages surrounding the engine liner. Liquid propellants have been utilized for the regenerative cooling of rocket motors for years, but ramjet engines present somewhat different problems, primarily because their relatively low fuel consumption limits the fuel flow rate.

An experimental investigation was made to determine the suitability of JP-4 fuel for the regenerative cooling of a hypersonic ramjet engine. Results showed that a properly chosen grade of JP-4 fuel could be used.

Information was obtained on heat-transfer rates, formation of coke, and pressure fluctuations as functions of tube-wall temperature and fuel bulk temperature in an electrically heated tube. Heat-transfer phenomena were investigated in the vicinity of the thermodynamic critical point of the fuel. Several effects were observed which have not previously been reported in the literature. Heat-transfer rates up to 1.8 Btu/sq in. sec were obtained with liquid and vapor fuel. Under the conditions of the test, very little coke was deposited in the tube, with tube-wall temperatures up to 1800 F. No severe pressure fluctuations were encountered.

An exploded view of the test section shown in above diagram for JP-4 fuel (60—HT-18)



An Analytical Study of Laminar Film Condensation...Part 1 Flat Plates..60—HT-37...By Michael Ming Chen, Massachusetts Institute of Technology, Cambridge, Mass. 1960 ASME-AiChE Heat Transfer Conference paper (multilithographed; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

The boundary-layer equations of momentum and energy are written in a modified integral form and solved for the case of laminar film condensation along a vertical flat plate. The analysis differs from previous works by employing the more realistic boundary condition of stationary vapor at large distances, instead of zero velocity gradient at the interface. Solutions for both the liquid film and vapor boundary layer are given for the case $\mu_v \rho_v \ll \mu \rho$. Velocity and temperature profiles are obtained using perturbation method and the modified integral boundary-layer equations.

The results show a significant negative velocity gradient at the interface as a result of vapor drag except for small values of $k\Delta t/\mu\lambda$. Theoretical heat-transfer coefficients are computed and found to be lower than previous theories, especially for low Prandtl numbers. Comparison with experimental heat-transfer data is given. The heat-transfer results are also presented in the form of an approximate formula for ease of application.

Optimization of a Sandwiched Thermoelectric Device..60—HT-24...By B. W. Swanson, E. V. Somers, and R. R. Heikes, Westinghouse Research Laboratories, Pittsburgh, Pa. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

Since it is desirable to operate thermoelectric power devices with large temperature drops so that the thermal efficiency is as high as possible, it is necessary to have the thermocouples operate over a large temperature interval. In

the present state of material development, no single thermoelectric material is satisfactory for use over the complete temperature range. It is therefore necessary to use different materials in each temperature range. This may be accomplished in two ways. The materials may be used in stages such that each stage operates over a fixed temperature interval while being electrically insulated from but thermally in contact with the remaining stages. The other method is to form each leg of the couple by joining in series; that is, forming a sandwich structure of the appropriate thermoelectric materials for each range. Simplified design equations of a thermocouple of sandwich construction, optimized to approximate the maximum thermal efficiency, were coded for an IBM 704; the equations and an example showing computed results are presented.

For suitable input data, the computer determines the thermocouple design that approximately maximizes the thermal efficiency of the device. A verification of the analysis indicates that the difference between the approximately optimum efficiency and the optimum efficiency is negligible.

An Analytical Study of Laminar Film Condensation...Part 2 Single and Multiple Horizontal Tubes..60—HT-38... By Michael Ming Chen, Massachusetts Institute of Technology, Cambridge, Mass. 1960 ASME-AiChE Heat Transfer Conference paper (multilithographed; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

The boundary-layer equations for laminar film condensation are solved for (*a*) single horizontal tube, and (*b*) a vertical bank of horizontal tubes. For the single-tube case, the inertia effects are included and the vapor is assumed to the stationary outside the vapor boundary layer. Velocity and temperature profiles are obtained for the case $\mu_v \rho_v / \mu \rho \ll 1$ and similarity is found to exist exactly near the top stagnation point, and approximately for most part of the tube.

Heat-transfer results computed with these similar profiles are presented and discussed. For the multiple-tube case, the analysis includes the effect of condensation between tubes, which is shown to be partly responsible for the high observed heat-transfer rate for vertical tube banks. The inertia effects are neglected due to the insufficiency of boundary-layer theory in this case. Heat-transfer coefficients are presented and compared with experiments. The theoretical results for both cases are also presented in approximate formulas for ease of application.

Determination of Boiling Film Coefficient for a Heated Horizontal Tube in Water-Saturated Wick Material..60—HT-11... By William D. Allingham and Jack A. McEntire, Assoc. Mems. ASME, Boeing Airplane Company, Seattle, Wash. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

The requirement for keeping liquid in contact with a heated surface during periods of high acceleration or in the absence of a gravitational field has provided the stimulus for two design approaches, each having certain advantages and limitations. Boilers wherein coolant is vaporized in a confined passage by the transfer of heat from the passage walls are often used but usually require means to store, distribute, and control the flow of coolant.

In an alternative method the control and distribution problems are eliminated by embedding the heat-exchange surface in absorbent wick material that has been saturated with a coolant.

In this study, boiling film coefficients for a 1.0-in-OD horizontal copper tube embedded in water-saturated ceramic fiber-wick material were correlated over a heat-flux range from 1000 to 10,000 Btu per hr sq ft. The presence of wick material next to a heat-transfer surface decreases turbulence in the region near the surface, increases the effective surface area, and provides active sites for bubble formation. This produces a higher film coefficient at low heat flux than occurs with pool boiling. At higher heat flux, the wick-boiling film coefficient was lower than pool boiling.

Power

Industry's Need for Quality Electric Power Service..60—Pwr-2... By Robert W. Worley, Mem. ASME, United Engineers and Constructors Inc., Philadelphia, Pa. 1960 ASME-AIEE Power Conference paper (multilithographed, available to July 1, 1961).

If one were to ask the production managers of any industry just how often an electric power interruption may be tolerated, the answer would probably be "never." However, the cost of providing a power source with never an interruption might be far greater than the earning power of continuous production.

It appears that the proper solution to this problem must start with a complete study of the industry.

It is significant that in most agreements between industrial companies and utilities, the rates are very carefully outlined in detail, but very little is said about the service except perhaps the expected nominal delivery voltage and what is required of the customer to safeguard the utility.

The question of rates, although important, is subordinate to the need for continuous and constant power supply. There appears to be need for greater understanding between utility power sales and distribution departments and those operating industrial plants.

Voltage variations may not be of too great a concern to many of the old line industrial plants being operated under manual supervision as the individual machine operators in a nonautomatic plant simply restart any machines that stop due to power faults. But the installation of automation and the investment required for automatic machinery introduce much greater concern for continuous operation.

Economic factors of standby power, and possibilities for voltage and frequency regulation are presented.

It is hoped that co-operation between all those concerned with electric power will eventually make possible solutions to most mechanical and electrical problems, and reductions in the frequency of electrical power disturbances.

Thermal Stress Protection in Starting and Loading Boiler-Turbine-Generator Combinations..60—Pwr-3... By R. H. Reisinger and C. B. Scharp, Mems. ASME, Baltimore Gas and Electric Company, Baltimore, Md. 1960 ASME-AIEE Power Conference paper (multilithographed; available to July 1, 1961).

Electric system peak loads have increased so rapidly that the new, high-temperature, high-pressure base-loaded units of a few years ago are now required to carry normal load swings, and operating economy demands frequent shutdowns during periods of light system load. Load conditions on the Baltimore Gas and Electric Company's system are requiring units of the newer 1450 psig, 1050 F class to be started frequently. Turbines designed for this higher pressure, higher temperature operation present more severe problems during starting, in order to prevent thermal shock, than those which previously had been encountered in the older machines with less critical initial steam conditions.

Turbines designed with integral steam chests, so that thick and thin sections are juxtaposed, are particularly prone to cracking during starting. Some years ago, several of our 850 psig, 900 F units

experienced shell cracking, after they had been subjected to increased frequency of shutdowns. Cracking of one was so severe that complete replacement of the high-pressure shell was necessary. A direct correlation between frequent starting and loading cycles and shell cracking is known to exist. These facts prompted the study and development of procedures for better turbine protection during these periods.

The boiler superheater and generator-rotor limitations and requirements were recognized and integrated into over-all starting procedures that provided effective protection for the boiler-turbine-generator combination. This paper discusses the development of these procedures with emphasis on the use of either an external or an internal turbine stop-valve bypass in the main steam line to the turbine.

The operations involved in the use of such a valve are outlined.

Code Testing of Large Boilers—Input-Output or Heat-Loss Method?..60—Pwr-5...By J. A. Bostic and W. F. Long, Assoc. Mems. ASME, The Cleveland Electric Illuminating Company, Cleveland, Ohio. 1960 ASME-AIEE Power Conference paper (multilithographed; available to July 1, 1961).

For a number of years, boiler testing has been an important part of the testing program at the authors' company because up-to-date information about boiler efficiency is required for the economic loading of the generating system as well as in scheduling maintenance and evaluating boiler operation.

In the past 19 years, forty tests of eleven large coal-fired, high-pressure boilers have been conducted. All but three of these tests were combination input-output and heat-loss tests.

In the past, efficiency was determined by input-output measurements and the heat losses were used to determine the cause of poor performance. The unaccounted-for difference between input-output and heat losses was considered unimportant because it was thought to be made up of a number of small uncontrollable losses. Recently, however, significant numbers of operators are not equipping large boilers with accurate fuel-measuring devices, so the heat-loss method of determining efficiency has taken on a new importance. In recognizing this trend, the committee that is presently revising the Power Test Code for Steam Generating Units has expanded the section of the code on heat losses to include all of the heat losses that can be measured. In other words, they are trying to eliminate the unaccounted-for.

One purpose of this paper is to compare the results of the input-output and heat-loss efficiencies in light of this recent development in recognizing heat losses.

In reviewing the present code, the committee has suggested that a change be made in the definition of boiler efficiency. The second purpose of this paper is, therefore, to compare the old efficiency with the new efficiency—both by heat loss and by input-output.

In order to have a common base for comparison, all of the comparisons in the main body of the paper are made from one set of test data. These data are from the most recent full-scale acceptance test.

Eight Years' Experience With Automatic Burner Controls..60—Pwr-6...By Ross Forney, Forney Engineering Company, Dallas, Texas. 1960 ASME-AIEE Power Conference paper (multilithographed; available to July 1, 1961).

In the past eight years, the author's company has installed 33 automatic burner-control systems on its large power boilers.

Each of these installations, along with another dozen being planned or constructed, incorporates a fully automatic burner-lighting sequence and a pilot and main flame supervisory system. These systems are designed so a burner may be lighted or shut off from the control room or a central intelligence device.

Among these 33 installations, seven are oriented for computer control. Another dozen incorporate their own central intelligence device to light and shut off burners automatically with increase or decrease in the boiler load.

Some of the reasons why management and design engineers apply automatic burner controls to a central power station are given here. They include consideration of the safety of operation, the centralization of controls, the economy of manpower and fuel, and fast startup and shutdown. The second section of the paper deals with factors that influence the design of such a system.

Turbine-Exhaust Losses..60—Pwr-7...By C. E. Seglem, Assoc. Mem. ASME, and R. O. Brown, Mem. ASME, Westinghouse Electric Corp., Lester, Pa. 1960 ASME-AIEE Power Conference paper (multilithographed; available to July 1, 1961).

The fluid dynamic losses in the steam-turbine flow path, although relatively small in the modern machines of today, represent a significant portion of the total losses in a power-plant cycle. The distribution of these losses throughout the turbine is somewhat dependent upon the turbine size and steam conditions, the manufacturer's basic design philosophy, and the general aerodynamic quality of the flow passages.

One of the most important of these flow losses, is the loss in available energy due to the velocity of the turbine-exhaust steam and to the restrictive effect of the exhaust hood and associated structural members. This loss has been discussed frequently in the literature and is referred to as the "exhaust loss" or "total exhaust loss."

The total exhaust loss is usually thought of as consisting of two primary components, the "leaving loss" and the "hood loss." The leaving loss is defined as the energy equivalent of the absolute velocity leaving the last rotating row of blades and, if unrecovered, it represents a loss in available energy to the turbine.

The hood loss is defined as the energy equivalent of the difference between the static pressure at the blade exit and the static pressure at the turbine-exhaust flange.

Experimental results of test programs conducted in the laboratory and on field units are described.

The results of this experimental program have been applied to the design of new turbine-exhaust hoods. The improvement in hood performance due to this redesign has been established through laboratory and field traverse testing under actual operating conditions.

Automatic Control

Preliminary Design of a Roll-Stabilization System for a Ship..60—JAC-1...By David V. Stallard, Feedback Controls Inc., Natick, Mass. 1960 Joint Automatic Control Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to July 1, 1961).

The history of attempts to stabilize ships against rolling is quite varied and interesting, and it goes back at least as far as 1883.

Water chambers, pumped tanks, moving weights, and even immense gyroscopes have been used. Almost every modern system of roll damping uses servo-controlled fins in pairs, whose motion is ordered by instrumentation such as gyroscopes that sense the vessel's rolling.

Acting like small aircraft wings, the fins develop hydrodynamic lift and cause a roll moment that counteracts the ship's roll.

The roll stabilization of a ship with servo-operated fins is analyzed as a system problem from the viewpoint of a control engineer. The preliminary design of a roll-damping system for a particular passenger ship is set forth. The roll-angle response to a sinusoidal sea-torque

is analyzed, and the improvement made by the roll-damping system is evaluated. A rate gyro of good resolution and a damped pendulum are adequate for roll-sensing instrumentation. A preliminary design for a valve-controlled fin servo is made, but it is so wasteful of power that a pump-controlled fin servo is designed as an alternative. Energy aspects of control systems in general are considered briefly.

Dynamic Synthesis of Higher-Order, Optimum Saturating Systems..60—JAC-2... By Fred Kurzweil, Jr., IBM, General Products Division, Development Laboratory, San Jose, Calif. 1960 Joint Automatic Control Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to July 1, 1961).

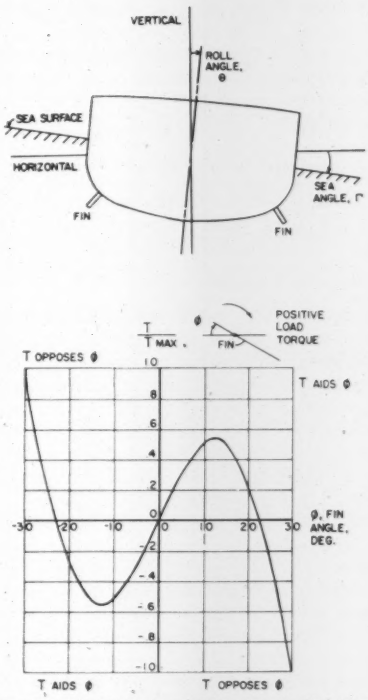
A new technique for the synthesis of optimum switching criteria for higher-order saturating systems is investigated. Basically, the technique consists of generating a linear switching criterion that is equivalent to the optimum switching criterion for each state of the system. Thus as a trajectory of the system is traced out, the optimum forcing function is determined point by point, resulting in the optimum trajectory for the system. The synthesis procedure has been proved experimentally by simulation of a third-order system on an IBM 797 digital computer.

The Optimum Response of Second-Order, Velocity-Controlled Systems With Contactor Control..60—JAC-3... By Irmgard Flügge-Lotz, Stanford University, Stanford, Calif., and Mih Yin, IBM Research Laboratory, Yorktown Heights, N. Y. 1960 Joint Automatic Control Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to July 1, 1961).

The optimum control problem for plants is described by second-order differential equations with constant coefficients and with velocity control. Emphasis is placed on the case where the characteristic equation of the system has one zero root and two complex conjugate roots. The problem is studied in terms of the motion of the phase point in a three-dimensional phase space. An iteration method is developed to obtain the optimum trajectory, which in turn gives the optimum response.

Pulse-Width Relay Control in Sampling Systems..60—JAC-4... By Winston L. Nelson, Bell Telephone Laboratories, Whippany, N. J. 1960 Joint Automatic Control Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to July 1, 1961).

The use of pulse-width control for the on-off regulation of systems subject to sampling is investigated in this paper. The inherent inability of simple on-off control to achieve accurate, or dead-beat control in sampling systems is demonstrated, and methods for predicting and minimizing the limit-cycle behavior of these systems are given.



Section of ship through fins, above. Steady-state hydrodynamic torque on fin versus fin angle, below (60—JAC-1).

It is then shown that if the on-off control is modified by allowing control of the "on" time during each sampling period, it is possible to achieve asymptotically stable dead-beat control. Sufficient conditions for the asymptotic stability in the large of pulse-width control systems are developed, using the "second method" of Lyapunov. Practical design of pulse-width controllers is developed from the theoretical results and some experimental evaluations are given.

Design of Optimum Multivariable Control Systems..60—JAC-5... By E. B. Lee, Assoc. Mem. ASME, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn. 1960 Joint Automatic Control Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to July 1, 1961).

Most controller design is based at present on the point of view of analysis; the system is first constructed, at least in form, and then the complete system is analyzed to see if the performance is satisfactory, after which it is again adjusted and then reanalyzed. This procedure may be satisfactory for a number of cases in which there are only a few control parameters to adjust.

Consider, however, the case in which we desire a better control, and there are several independent forcing functions.

The design of optimum controllers is considered for processes that are described by linear differential equations with one or more independent forcing terms. After presentation of a general method for designing what is usually a nonlinear controller, applications are made to: (*a*) Design of minimum energy controllers, (*b*) design of minimum response time controllers, and (*c*) design of minimum error controllers.

Reduction of Dimensionality, Dynamic Programming, and Control Processes..60—JAC-6... By Richard Bellman and Robert Kalsba, The RAND Corporation, Santa Monica, Calif. 1960 Joint Automatic Control Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to July 1, 1961).

A major difficulty in the way of a successful systematic approach to the study of control processes by way of the theory of dynamic programming is the occurrence of processes having state vectors of high dimension. However difficult the problem is for systems ruled by a finite set of differential equations, it is several orders of magnitude more complex for systems of infinite dimensionality and for systems with time lags.

By combining a technique presented earlier for dealing with finite dimensional systems and various methods of successive approximations and quasi-linearization, certain classes of control processes associated with infinite dimensional systems can be treated. The ideas are illustrated by discussing control of a system involving a time lag and control of a thermal system.

Kinetic Lyapunov Function for Stability Analysis of Nonlinear Control Systems..60—JAC-7... By S. S. L. Chang, New York University, New York, N. Y. 1960 Joint Automatic Control Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to July 1, 1961).

Lyapunov's second method is one of the most general and powerful ways of analyzing the stability of nonlinear and time-dependent dynamical systems.

The kinetic Lyapunov functions described in this paper are essentially a special or subclass of Lyapunov functions, although the method is arrived at from a slightly different point of view: Instead of finding the condition for the state variables x to approach some equilibrium value x_e, a sufficient condition for the time derivatives $\dot{x}$ to approach zero is found. Obviously, as x approaches zero, the system arrives at one of its equilibrium points, and the two results are equivalent if the equilibrium point is unique.

Improvement of the Power Efficiency of a Hydraulic Control System by the Use of a Gain Compensated Control Valve..60—JAC-8...By S. Y. Lee, Massachusetts Institute of Technology, Cambridge, Mass. 1960 Joint Automatic Control Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to July 1, 1961).

Valve-controlled hydraulic systems are used widely in many relatively low-power, fast-response applications. The power efficiency of such systems is generally poor due to the very nature of the control valve, which functions by its throttling action. Improving the power efficiency means reduction in size and weight of the hydraulic system, which often includes relatively heavy equipments such as a power source, a hydraulic pump, an accumulator, and "cooling" system. A small percentage of reduction in size and weight can be very significant in many airborne applications. A smaller hydraulic power supply system also means less initial cost as well as less running cost which are important considerations in industrial applications.

Conventional control valves are so constructed that the orifice area of the valve varies according to the input signal (henceforth, they will be referred to as area-controlled valves). The flow which the valve controls is not only a function of input signal but is also a function of other variables such as load pressure and supply pressure.

The purpose of this paper is to demonstrate that this relatively simple method of control is not necessarily the best from either the power-efficiency or the performance viewpoint. The reasoning is that, in the control process, both the load pressure and the supply pressure can change considerably. The gain of the valve, or flow variation per unit signal variation, therefore is not a constant.

When a closed-center four-way valve is used for position control, the flow gain of the valve can vary with load variation as well as supply pressure variation. The allowable gain variation of a system depends on the stability requirement and the dynamic-response requirement. If the dynamic requirement is very stringent, the allowable gain variation will be small and vice versa. It also can be proved that the allowable flow-gain variation depends on the level of the working pressure, which is closely related to the power efficiency of the system. Everything else being equal, the higher the load pressure, the more efficient will be the system.

The main advantage of a flow-feedback valve is that the flow gain is constant over a wide load-pressure band and a wide supply pressure band. It is possible to have the best power efficiency without sacrificing the dynamic performance. The net gain in power efficiency of a constant-gain valve over an area-control valve depends on the load characteristics and on the dynamic requirements.

Investigation of Periodic Modes of Sampled-Data Control Systems Containing a Saturating Element..60—JAC-9... By W. E. Meserve and H. C. Torng, Cornell University, Ithaca, N. Y. 1960 Joint Automatic Control Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to July 1, 1961).

A direct and concise means of studying the stability of a sampled-data control system with a saturating element is still not available. In such a system, instability may bring about periodic oscillations, or nonperiodic oscillations, or both. A periodic oscillation here means that the period of this oscillation is related to the sampling period by a rational number.

A discrete sequence approach is presented in this paper for investigating the possible modes of sampled-data control systems containing a saturating element. This method enables the investigator (*a*) to determine whether or not a control system has certain periodic modes, and (*b*) if it does, to identify them exactly. This approach is applicable to a sampled-data control system of any order. It is extended to the cases where the form of feedback is other than unity.

Approximate Method for Calculating the Time Response in Linear, Time-Varying, and Nonlinear Automatic Control Systems..60—JAC-10...By B. Naumov, Academy of Sciences, Moscow, USSR. 1960 Joint Automatic Control Conference paper (in type; to be published **Trans. ASME—J. Basic Engng.**; available to July 1, 1961).

In past years many methods have been developed for calculating the time response in automatic control systems. In this paper an improved, approximate method for calculating the transient response in linear (Section 1), time-varying (Section 2), and nonlinear (Section 3) automatic control systems, is developed on the basis of previous works.

The basis of this method lies in an approximate solution of integral equations by means of special tables which are given in the Appendix. These tables enable the user to shorten the time for calculation.

This method also can be useful for obtaining programs for digital computers. In each part of the paper, examples are given to illustrate the use of this method. These examples are identical to those of Boxer and Thaler and facilitate a comparison of the solution method developed in the paper with their z-transform approach.

Solution Space Approach to Optimal Control Problems..60—JAC-11...By Yu-Chi Ho, Harvard University, Cambridge, Mass. 1960 Joint Automatic Control Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to July 1, 1961).

During the past few years, the problem of optimal control of dynamic systems has received considerable attention. In general terms, the problem is the determination of controllable inputs to a system subject to various constraints such that the output of the system corresponds as nearly as possible to some desired behavior according to a specific criterion. A class of the general optimal control problem involves the minimization of time required to reduce a given dynamic system to rest from any arbitrary state, the time optimal control problem.

The purpose of this paper is twofold: To show that the general optimal control problem in the discrete case can be formulated as a problem in nonlinear programming, amenable to treatment by techniques developed in operations research; and to provide a different approach to the problem and derive certain additional properties concerning the solutions. The discrete time optimal control program is investigated in detail by fairly elementary algebraic and geometrical means which reveal some known as well as new properties.

New Results in Linear Filtering and Prediction Theory..60—JAC-12...By R. E. Kalman, Research Institute for Advanced Study, Baltimore, Md., and R. S. Bucy, The Johns Hopkins Applied Physics Laboratory, Silver Spring, Md. 1960 Joint Automatic Control Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to July 1, 1961).

A nonlinear differential equation of the Riccati type is derived for the covariance matrix of the optimal filtering error. The solution of this "variance equation" completely specifies the optimal filter for either finite or infinite smoothing intervals and stationary or nonstationary statistics.

The variance equation is closely related to the Hamiltonian (canonical) differential equations of the calculus of variations. Analytic solutions are available in some cases. The significance of the variance equation is illustrated by examples which duplicate, simplify, or extend earlier results in this field.

The Duality Principle relating stochastic estimation and deterministic control problems plays an important role in the proof of theoretical results. In several examples, the estimation problem and its dual are discussed side-by-side.

Properties of the variance equation are of great interest in the theory of adaptive systems. Aspects of this are considered.

Human Engineering

Manual Control of Undamped Systems Subjected to Force-Coupled Accelerations..60—SA-36...By P. Robert Knaff, General Electric Company, Philadelphia, Pa. 1960 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1961).

The process of returning a vehicle from space can be divided arbitrarily into four conceptual phases: positioning the vehicle from its orbital attitude to one in which the retro-rockets can be fired; control during retro-rocket firing; control during re-entry; and finally, landing the vehicle.

The typical problem that appears during retro-rocket firing is precipitated by a misaligned retro-rocket. When fired in this situation, in addition to the thrust vector that acts through the vehicle's center of mass, the misalignment may produce another force component that tends to spin the vehicle. The main purpose of this study was to investigate the display-control problems associated with controlling a vehicle subject to this type of perturbation.

Eight human subjects, four pilots and four nonpilots, used two types of control, on-off and proportional, to regulate the attitude in pitch and yaw of a vehicle subjected to two magnitudes of upset torque originating from one of ten angles.

The results and their implications for future study are discussed.

Aviation

An Experimental Sodium Vapor Power Plant..60—Av-28...By J. T. Congelliere, T. A. Coultas, and H. L. Burge, North American Aviation, Inc., Canoga Park, Calif. 1960 ASME Aviation Conference paper (multilithographed; available to April 1, 1961).

An ion rocket-propulsion system will require a power supply that is extremely reliable, compact, low weight, and capable of unattended operation for durations up to one year.

There are numerous ways of developing electrical power for a space-borne vehicle. This work examines only the conventional thermodynamic heat cycles since their relatively advanced state of development would permit early utilization.

The primary objective of the program was to investigate the problems of operating a boiling alkali-metal loop. The ultimate goal was to operate a turbine-generator set producing power at high efficiency and high inlet temperature for an indefinite period of time. Sodium was selected as the most suitable thermodynamic working media for actual experimental testing because of cost factors and familiarity. However, the system was designed for use with either sodium or rubidium. A minimum requirement was to circulate rubidium at 1500 F through a converging-diverging nozzle, which was used in lieu of a turbine.

ASME TRANSACTIONS

The October, 1960, issue of the Transactions of the ASME—*Journal of Engineering for Power* (available at $1.50 per copy to ASME Members; $3 to nonmembers)—contains the following:

Journal of
ENGINEERING FOR POWER
Volume 82 • Series A • Number 4

247 Throat Tap Nozzles Used for Accurate Flow Measurements, by K. C. Cotton and J. C. Westcott. (59—A-174)

264 Water-Treatment, Corrosion, and Internal-Deposit Studies for Eddystone, by R. C. Ulmer, H. A. Grabowski, and R. C. Patterson. (59—A-147)

275 The Selection of Materials and Fabricating Techniques for the Eddystone Boiler and Sulzer Control Valves, by E. C. Chapman and R. E. Lorentz, Jr. (59—A-318)

286 Development Associated With the Superpressure Turbine for Eddystone Station Unit No. 1, by W. E. Trumpler, Jr., A. F. LeBreton, E. A. Fox, and R. B. Williamson. (59—A-288)

293 Material Selection and Fabrication, Main Steam Piping for Eddystone No. 1, 1200-F and 5000-Psi Service, by R. H. Caughey and W. G. Benz, Jr. (59—A-327)

315 Solar Turbo Power-Plant Design, by D. B. Mackay and E. L. Leventhal. (59—A-74)

325 Analysis of Solar-Furnace Performance in Mechanical Testing at Extremely High Temperatures, by G. S. Leon and M. E. Shank. (59—A-79)

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COMMENTS ON PAPERS

The Low-Level Economizer: A Design Study

Comment by Joseph Waitkus[1]

THE authors of this paper[2] have placed into the record a most interesting study of another form of cold-end temperature control for rotary regenerative air preheaters.

We appear to be continually looking to that ultimate goal of recovering every Btu of energy available. We know that in doing so we risk the creation of a number of problems. To achieve the goal we must complicate the operating system. We realize there will be increased capital cost, and sometimes, increased operating costs will be involved.

The scheme proposed, consisting of a low-level economizer and an air-tempering coil with a common circulating fluid, is essentially two heat exchangers coupled together. In a combination of this character the flow rate of the coupling fluid must be carefully balanced with the flow rate of the air and flue gases in order to attain the optimum in heat transfer. In essence, it is a case of balancing the heat capacity of three fluids.

The arrangement is not without its problems. For each change in boiler load there will be a different flow rate required for the coupling fluid. Furthermore, for each change in the ratio of air and flue gases—as in the case of a change in fuel—there will be an adjustment necessary in the coupling fluid flow rate.

One question comes to mind. Are we projecting the problem of corrosion and deposits to equipment beyond the air preheater where it might not lend itself to easy and adequate control and maintenance?

It is generally recognized that the rotary regenerative air preheater includes features for the control of corrosion and deposits and for maintaining high availability and reliability under the most difficult conditions of fuels and metal-temperatures.

The regenerative air preheater with its built-in soot blower for steam or air, its water-washing system for in-service operation, and its easily replaceable cold-end surface permits a wide latitude of cold-end conditions with a minimum of complication in arrangement, operation, and maintenance. Why not, then, risk higher recoveries and lower exit gas temperatures in the air preheater?

The use of corrosion-resisting materials offers some prospects for relief. Such materials as Corten, Mayari-R, Yoloy, and N.A.X., to mention a few, have proved properties suited to corrosive conditions and within the limits of reasonable costs. Stainless steels, suitable only in certain grades, are expensive and, in some instances, hard to justify. It might be added here that baked enamel coatings have aided the battle against acid corrosion with only a little over the cost of the bare metal surface fabricated from corrosion-resisting materials. This general observation applies to the entire system from the air preheater to the stack outlet. Stacks fabricated of Corten steel have been used for a considerable time with excellent results.

As the authors suggest, an optimization study should be made to establish the most practical combination of economizer and air-tempering coil. It would be a valuable extension of this investigation and may bring to light other facets of the scheme not apparent at this point. However, there is some doubt that this scheme would ever replace a part of the regenerative air preheater unless space and weight considerations were ignored.

There is one additional study that might be considered and that is to compare the value of lower exit gas temperatures against the cost of replacing the cold-end heating surface. Thoughts in this direction are beginning to assume some prominence in special instances, and the subject may be worth exploring on a more intimate basis.

As a final suggestion, a German technical article by Alberts Upmalis entitled "Indirect Preheating of Combustion Air" is recommended for study. The article is featured in the December, 1958, issue of *Brennstoff-Waerme-Kraft*, pages 569–571. In many respects it is apropos to the subject of this paper.

The authors should be complimented for a most interesting contribution. It is to be hoped they will continue their investigations and report on them for our further benefit. We are in the midst of an intense campaign to achieve higher operating economies. Such studies and schemes as proposed in this paper open new avenues to attaining that ultimate goal of complete recovery of the energy in our rapidly changing fuel situation, with quality deteriorating and costs rising.

Comment by L. A. Darling[3]

The authors deserve the thanks of everyone concerned with fuel-burning equipment for the excellent job they have done in preparing this analysis of performance of a low-level economizer. Those of you who have been through heat-balance calculations can appreciate the amount of laborious calculation required to prepare a study of this kind.

It is believed true that in the end the principal interest of most of us is the answer to the question: "Will it pay off to operate an economizer below the dew point of the flue gas?" It is noted that the return on the extra investment which

[1] Manager—Special Applications, The Air Preheater Corporation, Wellsville, N. Y. Mem. ASME.

[2] J. H. Potter and R. C. King, "The Low-Level Economizer," MECHANICAL ENGINEERING, vol. 82, June, 1960, pp. 66–70.

[3] Supervising engineer—Power, Engineering Department, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. Mem. ASME.

the authors have arrived at is 59 per cent. This I understand to be the gross return and from this, of course, certain deductions must be made to arrive at net return. Fixed charges on the extra investment will probably be between 15 per cent and 16 per cent. If only normal maintenance cost is assumed for this equipment, this will be in the range of 8 per cent to 9 per cent of the extra investment. Deducting fixed charges and maintenance charges results in an indicated net return of perhaps 35 per cent on the investment when fuel cost is 40 cents per million Btu. In those areas in which fuel cost is below 40 cents per million Btu, both gross and net savings would be correspondingly lower.

There is, of course, a question which must be asked as to whether severe maintenance problems can be avoided when an economizer is operated below the dew point of the flue gas. If maintenance of this part of the system proves to be a severe problem, then the reliability of the boiler and the unit as a whole become involved.

Provision of bypass ducts and dampers of the size necessary to bypass the flue gas around the economizer would be neither simple nor inexpensive. If provision is made to operate the boiler with the low-level economizer out of service, then arrangements for maintaining the cold end temperature of the air heater above the dew point must also be made. This can be accomplished by provision of extra capacity in the air-tempering heater and in the steam lines which supply it. This, however, also would increase the investment which would tend to reduce the attractiveness of this investment.

Experience in operation of economizers below the dew point in Europe and in the British Isles has been reported in the literature and to this society. However, in Europe they have more incentive to do this because their fuel costs are in the range of 50 cents to 60 cents per million Btu compared to our costs which are frequently in the range of 30 cents to 40 cents per million Btu.

Upon making inquiry of several powerplant designers and managers in Europe during the past two years on this subject, I found them to be generally of the opinion that the difficulties of maintenance due to corrosion and deposits have not been fully and economically solved. It appears that this view has restricted more widespread use of low-level economizers in those high fuel-cost countries.

Clearly, the design of a low-level economizer so that it can be maintained in service for extended periods of time without building up excessive draft losses and at the same time keeping its cost within economic limits is a problem of no small complexity. It appears further that demonstration of an adequate answer to overcome these difficulties is the key to wider adoption of this device in this country. It is gratifying to learn that progress is being made in this direction.

Authors' Closure

The authors wish to thank J. Waitkus and L. A. Darling for their penetrating comments and suggestions. It is only by such interchange of ideas that such remarkable progress has been achieved by the power industry in recent years.

Mr. Waitkus suggests that it might be in order to study the economics of an extension of the surface in the regenerative air heater. The authors agree that such a study would be extremely worth while. As was stated in the original paper, there are various ways in which the flue-gas energy can be utilized within the cycle: certainly one of these methods is the extension of the air-heater surface.

The availability of corrosion-resistant materials and baked-on enamel coatings makes the consideration of an increased air-heater surface attractive. The authors' approach to the over-all problem must be considered as only one of the steps that must be traced toward the complete solution. With more time and computational aid, other equally important factors could be investigated.

Mr. Darling points out that the installation of a low-level economizer is intimately connected with the cost of fuel. That is to say, such a device might be economical in a 60-cent fuel zone, but might be definitely uneconomical in a 30-cent fuel zone. The authors hasten to agree with this comment and wish to add that operating regimen, fuel cost, and ambient temperatures were selected in their paper merely to define a means of solution. Any utility, using the method established in the paper, can introduce its own figures for capital charges, fuel costs, and operating schedule. Had time permitted, the authors would have prepared families of curves using fuel cost and capital charges as parameters, so that at least approximate dollar savings could be read off for varying conditions.

The authors particularly appreciate Mr. Darling's comments relative to provision for maintenance when operating at temperatures beneath the flue-gas dew point. Only extended operating experience can establish the possible deleterious effects of corrosion and deposits. Initial installations may require alternate air-heater protection devices installed as a safeguard against shutdown of the low-level economizer for maintenance or repair. As Mr. Darling points out, the necessary bypass ducts and dampers could be costly.

With continued interest on the part of the power industry, greater use will undoubtedly be made of the energy now being wasted in stack gases. The steps toward the solution of this problem are difficult in that they involve technological, economic, and civic aspects. The technological problems are mechanical, chemical, and metallurgical. The economic aspects involve reliability and fixed and operating costs. The civic problems have to do with air-pollution and nuisance considerations.

In the present paper, the authors have discussed the details of some of the technological steps. They would be pleased to see an elaboration of these steps as well as a discussion of some alternate ones.

J. H. Potter.[4]
R. C. King.[5]

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[4] Dean of Graduate Studies, Stevens Institute of Technology, Hoboken, N. J. Mem. ASME.

[5] Consultant, Gibbs and Hill, Inc., and professor, New York University, New York, N. Y. Mem. ASME.

Standard Costs for Manufacturing

By Stanley B. Henrici. Third Edition. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 402 p., $6^1/_4 \times 9^1/_4$ in., bound. $8.50. Completely revised, this third edition has four sections. Part one discusses the standard cost system, its concepts, development, accounting procedures, and variance accounting. Part two is concerned with the setting of cost standards, for direct and indirect labor, materials, utilities, general overhead, and maintenance and other services. In part three the standards are applied to operations, and variances in the costs are discussed, introducing variance analysis, control, and tabulation. The final section discusses such miscellaneous items as operating budgets, incentive plans, salary evaluation, and some short cuts in preparation of standards and in accounting.

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Stufenlos Verstellbare Mechanische Getriebe

By Friedr. W. Simonis. Second Edition. 1959, Springer Verlag, Berlin, Germany. 190 p., $6^1/_2 \times 9^1/_4$ in., bound. DM 29.40. A comprehensive presentation of the more important infinitely variable speed transmission. Starting with an introduction to the general subject of changing rotational speeds, there follow extensive chapters on the various types of friction-wheel, v-belt or chain, and free-wheeling-clutch transmissions. Newer aspects, such as the increase of the transferable capacity, and the expansion of the range of adjustment, are also discussed.

Symposium on Hydraulic Fluids

Published 1960 as Special Technical Publication No. 267 by the American Society For Testing Materials, Philadelphia, Pa. 102 p., $6^1/_4 \times 9^1/_4$ in., bound. $3.75. There are three papers on problems and trends in the use of hydraulic fluids—a general survey, and automotive and aircraft hydraulic systems, and also papers on new development and evaluation methods for marine, aircraft, and industrial hydraulic fluids, including fire-resistant fluids.

Symposium on Radioisotopes in Metals Analysis and Testing

Published 1960 as Special Technical Publication No. 261 by the American Society For Testing Materials, Philadelphia, Pa. 62 p., $6^1/_4 \times 9^1/_4$ in., bound. $2.75. Four survey papers discuss general types of analysis using radioisotopes, such as thickness gaging, absorptiometry, radiometry, activation and isotope dilution assays, and the proper instrumentation for these methods. The remaining four papers describe current industrial activity, including the analysis of tungsten and of aluminum for trace impurities, and the training of personnel in the utilization of radioisotopes.

Theory of Machines

By Bevis Brunel Low. Third Edition. 1958, Longmans, Green and Co., Inc., New York, N. Y., 621 p., $5^3/_4 \times 8^3/_4$ in., bound. 25s. Intended for the engineering student, but also helpful for the draftsman and designer, this third edition has additional matter on gyroscopic motion, velocity and acceleration, toothed gearing, epicyclic trains, inertia forces in mechanisms, and vibrations. There are also chapters on balancing, dimensions, and dynamical similarity, governors, analysis of cams, and friction, including clutches. The analytical theory of five types of brakes is given, including brakes with external-contracting pivoted shoes; special attention has also been paid to the inertia effect of a connecting rod, to creep of belts, and to helical, spiral, and epicyclic gears.

Units, Dimensions, and Dimensionless Numbers

By D. C. Ipsen. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 236 p., $6 \times 8^3/_4$ in., bound. $6.50. This discussion of the concept of units and dimensions emphasizes theory, introducing techniques as the systematic application of theory. The nature of physical ideas and relations, the physical and mathematical nature of units, conversion, similitude, and the units and dimensions of mechanics, thermodynamics, and electricity are described, and the final chapters discuss dimensionless numbers, geometrically dissimilar systems, and the techniques of dimensional analysis.

Advances in Aeronautical Sciences, Vol. 1 and 2

1959, Pergamon Press, New York, N. Y. 2 vol., $6^1/_4 \times 9^3/_4$ in., bound. $30. These two volumes contain papers, mainly in English with some in French, German, or Italian. Survey papers discuss boundary-layer control, jet noises, human factors, hypersonic speeds, inertial guidance, space-propulsion methods, magnetofluid dynamics, and other topics. There are also papers for specialists, dealing with advanced mathematical methods and refined experimental techniques. These volumes constitute the Proceedings of the First International Congress in The Aeronautical Sciences, Madrid, 1958.

Automatic Refrigeration

By S. A. Andersen. 1959, MacLaren & Sons Ltd., London, England. 649 p., 7 × 10 in., bound. 85s. This book surveys the aims, principles, and techniques of refrigeration, and the principles of automatic control, studies the design, functions, and applications of automatic controls and fluid-flow regulating devices, and presents extensive photographs and descriptions of existing automatic refrigeration plants, mainly European. There is an extensive section of operating information, which includes calculation sheets such as those for heat transfer, fluid flow, and plant lay-out operations; conversion tables and tables of meteorological, physical, design, and other data; refrigerant tables in both British and metric units; and a bibliography and extensive literature survey.

Basic Principles of Nuclear Science and Reactors

By Alan M. Jacobs, and others. 1960, D. Van Nostrand Company, Inc., Princeton, N. J. 262 p., $6^1/_4 \times 9^1/_4$ in., bound. $6.50. Falling midway between theory and the practical approach, this discussion presents qualitative developments of the basic theory of fission chain reactions, without mathematical rigor, and then uses these concepts to analyze existing reactor systems. The opening chapters introduce relevant concepts of modern physics, and the closing chapters discuss subjects related to the operation and use of nuclear reactors. Appendixes include a chart of the nuclides, and tables of physical constants and conversion factors.

Britain's Scientific and Technological Manpower

By George Louis Payne. 1960, Stanford University Press, Stanford, Calif. 466 p., $6^1/_4 \times 9^1/_4$ in., bound. $8.50. This book is the result of study of British official documents dealing with technological manpower and education, made under the aegis of the President's Committee on Scientists and Engineers. This mustering of British manpower and educational statistics and description of postwar development and future demands is amplified by description of the British educational system and relevant social and economic factors. Suitable American statistics have been included where possible to provide an analogy.

The Correlation of Hinged Four-Bar Straight-Line Motion Devices by Means of the Roberts Theorem and a New Proof of the Latter

By A. E. Richard De Jonge. Published March 18, 1960, in The Annals of the New York Academy of Sciences, vol. 84, art. 3, pages 75–145. In this extensive paper the various known exact and approximate four-bar straight-line motion devices are briefly described. They are correlated by means of the Roberts Theorem, for which a simple and direct new proof has been developed. Some new forms of straight-line devices are also presented, and a correlation by means of the theory of curvature has been added.

Diesel and Gas Engine Catalog, 1960

Edited by Rex W. Wadman. 1960, Diesel Progress, Los Angeles, Calif. 436 p., $10^1/_2 \times 13^1/_2$ in., paper. $10. This newest edition of this annual catalog describes, and in many cases, illustrates the products of the manufacturers of diesel engines, superchargers, turbochargers, gas turbines, fuel-injection equipment, governors, transmissions, and accessories such as dampers, radiators, coolers, clutches, and torque converters. An average of four or five pages is devoted to each of approximately 125 manufacturers; characteristic aspects of the firm's products are outlined, and specifications for all models are given. Some foreign manufacturers are included.

Dynamics of Conducting Gases

Edited by Ali Bulent Cambel and John B. Fenn. 1960, Northwestern University Press, Evanston, Ill. 212 p., $7^1/_4 \times 10$ in., bound. $12.50. These papers of the 1959 Gas Dynamics Symposium are arranged in four sections: elementary processes and properties in ionized gases; theoretical considerations on the interaction of magnetic fields and flow of ionized gases; laboratory experience with ionized gas flow; and application of magnetogasdynamic effects.

Elements of Petroleum Reservoirs

By Norman J. Clark. Published 1960 by the Society of Petroleum Engineers of The American Institute of Mining, Metallurgical & Petroleum Engineers, 6300 North Central Expressway, Dallas 6, Texas. 243 p., $6^1/_4 \times 9^1/_4$ in., bound. $7. This book is concerned with the exploitation of petroleum reservoirs. Introductory chapters discuss the formation and physical characteristics of reservoirs, their rocks and fluids. Six chapters are devoted to oil wells, including natural displacement of oil, lease operations, operation for maximum recovery by mechanical means, and optimum production rates. Gas wells, miscible and combustion drives, and means of exploitation of petroleum reservoirs for maximum profit are also treated.

The Exploration of Space

Edited by Robert Jastrow. 1960, The Macmillan Company, New York, N. Y. 160 p., $7^1/_4 \times 10$ in., bound. $5.50. This is a survey of recent developments in the space sciences presented in individually authored

papers, originally presented at a Symposium on Space Physics in 1959. Included are discussions of the nature of the moon, Venus, and Mars; solid particles, plasma and magnetic fields in the solar system; astronomy from rockets, satellites, and space vehicles; and a survey of the present frontiers of space and the major problems of the future.

The Exploration of the Solar System

By Felix Godwin. 1960, Plenum Press, Inc., New York, N. Y. 200 p., $6^1/_4 \times 9^3/_4$ in., bound. $6.50. This prediction of future interplanetary travel, space stations, and the development of colonies on the planets is based on equipment now available or in the development stage. Diagrams show the construction of chemically propelled rockets, solar-powered vehicles, space laboratories, and robots. Tables of mass ratios, costs, personnel requirements, propellant mixtures, and the like are given. Much of the book is devoted to what the first explorers will do when they land on the moon, Venus, and Mars.

Flachentragwerke

By Karl Girkmann. 1959, Springer-Verlag, Vienna, Austria. 632 p., $6^1/_2 \times 9^1/_4$ in., bound. $17.15. A detailed treatment of the elastostatics of load-bearing structures, which discusses the important problems involved in the calculations of stresses and deflections in plates, shells, and prismatic structures. For practical use the analytic solution of a wide range of such problems is carried out, with particular attention to the underlying principles. An extensive list of references accompanies each of the five main sections.

Gmelins Handbuch der Anorganischen Chemie, 8th Edition

System No. 29, Strontium, Ergänzungsband. 306 p., $6^3/_4 \times 9^3/_4$ in., paper. $46.50. System No. 30, Barium, Ergänzungsband. 569 p., $6^3/_4 \times 9^3/_4$ in., paper. $84.50. Published 1960 by Verlag Chemie, Weinheim, Germany. These supplements to the previous "Barium" and "Strontium" volumes present the results of research in the years from 1931–1949. The supplements, however, form an obvious contrast with the 1931 and 1932 volumes. In addition to the exhaustive coverage of the literature on the elements barium and strontium, these volumes cover also the compounds of barium and strontium with the nonmetals as well as those with the metals arsenic, antimony, bismuth, the alkali metals, and the alkaline earth metals. Both volumes contain, as is now customary, English-language marginal translations of the German headings, as well as both German and English tables of contents.

Growth of Crystals

Edited by A. V. Shubnikov and N. N. Sheftal. 1959, Consultants Bureau, Inc., New York 11, N. Y. 2 vol., bound. $31. Vol. 1 contains in English translation 43 of the papers presented at the Moscow Institute of Crystallography's first convention on crystal growth in 1956; vol. 2 contains papers recording some of the work of Soviet scientists in the interval before the second convention. The papers in both volumes discuss theoretical and experimental investigations in the field, the apparatus and methods of growing crystals, and miscellaneous topics such as crystal dislocation and crystal growth kinetics. The second volume also contains a paper, given special mention by the editors, on the growing of synthetic corundum by S. K. Popov.

Heat Transfer and Fluid Mechanics Institute, Proceedings, 1960

Published 1960 by the Stanford University Press, Stanford, Calif. 259 p., $6^3/_4 \times 9^3/_4$ in., paper. $8.75. Beginning with this 13th meeting, contributions will be limited to the reporting of completed investigations rather than of continuing investigations as formerly. Topics covered in this volume include magnetohydrodynamic drive in a vortex, Navier-Stokes equations solutions, vortex flow, boundary-layer studies, supersonic flow problems, hemispherical emissivity, and explosive decompression of water.

High Productivity in Heavy Engineering

By A. G. Thompson. 1960, Iliffe & Sons, Ltd., London, England. 339 p., $5^1/_2 \times 8^3/_4$ in., bound. 65s. A book for anyone involved in the fabrication of metal by welding. The features of the different arc-welding processes are listed, with detailed consideration only of slag welding and welding of thick plate. Major consideration is given the machines for cutting and welding, methods of dimensioning, assembling, handling and inspection, and plant layout. Four final chapters discuss time standards, the use of cost data, the relation of cost to output, and productivity improvement.

IP Standards for Petroleum and Its Products, Part 1: Methods for Analysis and Testing

Nineteenth Edition. Published 1960 by the Institute of Petroleum, London, England. 783 p., $5^1/_2 \times 8^1/_2$ in., paper. No price given. Beginning with this 19th edition, the Institute will publish its Standards in four volumes. Vol. 1 comprises all the general laboratory methods which form the major portion of the IP Standards and includes certain small scale rig tests, specifications for IP Standard hydrometers and thermometers, and a table giving equivalence of ASTM and IP methods.

Impulstrechnik

By Frank Früngel. 1960, Akademische Verlagsgesellschaft, Leipzig, Germany. 575 p., $6^1/_4 \times 8^3/_4$ in., bound. 54 DM. Under the title "Impulse Techniques" the author deals with the generation and application of capacitor discharges. Separate chapters cover the transformation of capacitor-stored energy into current surges, voltage surges, heat pulses (welding), light pulses (e.g., stroboscopy), acoustic pulses, spark erosion, discharges, etc. Preliminary chapters cover general or basic aspects, and the final hundred pages are devoted to measurement methods for the various types of generated impulses.

Incompressible Aerodynamics

Edited by Bryan Thwaites. 1960, Oxford University Press, New York, N. Y. 636 p., $6^1/_4 \times 9^1/_4$ in., bound. $12. The first book of a new series, the Fluid Motion Memoirs, this volume provides a comprehensive review of certain flows of incompressible fluid and is a theoretical and experimental study of the uniform flow of air and other viscous fluids past two-dimensional aerofoils and three-dimensional wings. Related topics such as flows past joined bodies, shear flows, rotary flows, and boundary-layer control are also dealt with. The information contained here is essential for those in aerodynamics and is also applicable to areas such as gas turbines, pumps, compressors, ventilating systems, ships' stabilizers, and river erosion.

Introduction to Solids

By Leonid V. Azároff. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 460 p., $6^1/_4 \times 9^1/_4$ in., bound. $9.50. This is a general elementary treatment of the nature and properties of inorganic solids, designed to fill the need specialization creates in practice and in literature by concentration on single aspects of a subject. The crystallinity of solids is used as a framework for the discussion, which begins with geometrical crystallography, and the structure, atomic packings, mechanical properties, formation and transformation of crystals. The final six chapters deal in turn with the properties and structure of metals in general and of semiconductor and insulator solids. Appendixes list physical constants, conversion units, atomic radii, and space-group symbols.

Kinematics of Machines

By Rolland T. Hinkle. Second Edition. 1960, Prentice-Hall, Inc., Englewood Cliffs, N. J. 353 p., $6^1/_4 \times 9^1/_4$ in., bound. $7.50. Revisions in this edition include more extensive treatment of Coriolis' acceleration, and new discussions of the four-bar linkage, independent-position, and finite difference equations for velocity and acceleration analyses, the theory and application of complex variables for cam design, and Bennett's linkage. There are three entirely new chapters on dimensional synthesis, mechanical computing mechanisms, and constrained motion and number synthesis.

Kinematisch-Getriebedynamisches Praktikum

By Rudolf Beyer. 1960, Springer-Verlag, Berlin, Germany. 170 p., $6^1/_4 \times 10$ in., bound. DM 29.40. The purpose of this book is to explain the application of kinematic theory to complicated practical problems. Following a survey of fundamentals and a description of the Alembert, Wittenbauer, and Federhofer methods, the author deals with dynamics of drive mechanisms with double and multiple gears; multihinge linkages; gear trains; friction, etc., with particular attention to machine tools and other similar mechanisms. Kinetodynamic applications are covered, modern mathematical methods of complex number analysis are briefly considered, and practical numerical examples are given.

Man-Made Textile Encyclopedia

Edited by J. J. Press. 1959, Interscience Publishers, Inc., New York, N. Y. 913 p., $8^1/_2 \times 11^1/_2$ in., bound. $29.50. The arrangement is in topical chapters separately edited, containing monographs by American contributors from industry and government. Coverage is wide, from the raw materials through production and characteristics of fibers; fabrication and processing of threads, rope, textiles, and the like; techniques of textile engineering; dyeing, printing, and other finishing processes; apparel manufacture and renovation methods, to marketing methods and extensive description and tabulation of world and U. S. economics and statistics. Completing the volume are listings of world fiber trade-marks, a glossary, and an index.

Mathematical Methods for Digital Computers

Edited by Anthony Ralston and Herbert S. Wilf. 1960, John Wiley & Sons, Inc., New York, N. Y. 293 p., $7^1/_4 \times 10^1/_2$ in., bound. $9. The first chapter describes methods of generation of elementary functions on digital computers. The remaining chapters each present a mathematical discussion of a particular method followed by related papers of

special interest, all by authors in close contact with latest developments. The areas covered in these chapters are matrices and linear equations; ordinary differential equations; partial differential equations; and statistics. The final chapter contains six papers on miscellaneous methods, including those for numerical and multiple quadrature, and Fourier and network analyses.

Missile Aerodynamics
By Jack N. Nielsen. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 450 p., $6\frac{1}{4} \times 9\frac{1}{4}$ in., bound. $12.50. In arrangement, and selection and use of sources, this book reflects the author's particular point of view. An introductory chapter which includes comparison of missile and airplane aerodynamics, classification and flight angle of missiles, and a glossary of special terms, is followed by a chapter explaining common formulas used extensively throughout the book. Slender-body theory next is discussed as fundamental to the subject, followed by presentation of missile aerodynamics through description of the building-up of a missile from its component parts. The final chapters discuss drag and stability derivatives.

REVIEWS OF BOOKS

The Story of Engineering—A Thought-Provoking History

The Story of Engineering
By James Kip Finch. Doubleday & Co., Inc., Garden City, N. Y., Doubleday Anchor Original, 1960. Paperback, illus., xxvii and 528 pp., $1.45.

Reviewed by F. S. Blackall, jr.[1]

This engaging volume, one of the latest in Doubleday's series of Anchor paperbacks, well serves a dual purpose as an encyclopedic survey course in engineering history for the tyro and an effective review for the mature and well-read engineer.

The author traces the significant accomplishments of the professions which came to be known as engineering, from the master builders, the architects, and the skilled wielders of tools of Egypt's Pyramid Age, over 3000 years before Christ, to the creators of the outstanding works of our present era. In depth and breadth, the research which must have been required in the preparation of this fascinating book was a feat worthy of the distinguished leader of one of America's great engineering schools, the Department of Civil Engineering at Columbia University. It is a tribute to the author that he has been able to piece together the long and variegated succession of developments and discoveries of our professions through some 50 centuries, with such effective coherence that the resulting whole makes an eminently readable and readily comprehensible narrative. It will appeal alike to the youngster who dreams of a future in our field and the oldster who would whet his reminiscences of the great deeds of the past.

The book is spiced, too, with an extensive and remarkably well-chosen assortment of illustrations, diagrams, and engineering drawings, some ancient, some modern, which lend added interest to the text.

There is inspiration in these pages, salted by biographical data relating to our technical forebears, famous and obscure, who have left their footprints on the sands of time. Thus this pocket history deals not alone with structures, machines, and methods, but no less with the men who dreamed the dreams which made them possible.

A thread of philosophy runs through the volume which emphasizes the impact of engineering and mechanics upon the social structure and mores of one era and another. "Engineering," says the author, for example, "is basically a democratic art, an instrument of civilization destined to serve all the people. Its growth likewise demands mass support."

On the negative side, one wonders why a volume which can serve such a useful purpose as a quick reference work was not supplied with an index. Even for the one-time reader, such an appendix would be helpful in referring back, as the story of engineering unfolds, to earlier developments which cast their lengthened shadows on subsequent history.

Also from the point of view of the mechanical engineer, there may appear at times to be an overemphasis, in Dean Finch's opus, of civil engineering. This is something which one might consider natural enough in the brainchild of an eminent civil-engineering educator. Upon reflection, however, such a critique is probably unmerited and is no disparagement to Dean Finch's work, since those handmaidens, military and civil engineering, were the only recognized disciplines of professional engineering activity for 45 or more centuries out of the 50-odd embraced by the author's review. And so, indeed, it remained, until the rebirth of natural sciences in the seventeenth century and their great flowering during the nineteenth gave rise to a group of new and autonomous engineering professions in mechanical engineering, mining and metallurgy, chemistry, and electricity, and today in aeronautics, nucleonics, and space rocketry. Who knows what is to follow! Not the least of the merits of this volume is the manner in which it traces the rise of the new professions from their basic stratum in civil engineering.

Summary: A well-written and thought-provoking survey of the history of engineering from its roots in antiquity to its all-permeating part in modern life. Readable and skillfully presented, it is a noteworthy contribution to popular engineering literature.

[1] President and Treasurer, The Taft-Peirce Manufacturing Company, Woonsocket, R. I. Past-president and Fellow ASME.

THE ROUNDUP

Metrology Course to Be Established at George Washington University

AMERICA's first Institute of Measurement Science will soon be established at George Washington University's School of Engineering in Washington, D. C. Undergraduate students will be able to elect metrology as their major for the Bachelor of Science degree. Besides the BS, Master of Science and Doctorate of Science degrees will be offered by the Center. Classes will begin in February, 1961, and it is thus possible that this country will have its first graduates in metrology in 1963.

Announcement of the new educational center was made by Dr. Martin Mason, Mem. ASME, Dean of the University's School of Engineering, at a press conference in New York, Sept. 27, 1960. The Center will have the support of the National Bureau of Standards, and has received its first financial backing from The Martin Company of Baltimore, Md.

George Washington University is one of the few which already have some courses in metrology.

"Through this new Institute," Dr. Mason said, "America hopes to overcome Soviet superiority in the science of measurement—metrology—which has contributed greatly to Russia's missile and space achievements."

A representative of The Martin Company explained his firm's interest in promoting the Institute of Measurement Science. He said that they are constantly thwarted by lack of ability in fine measurement. This is particularly true in space technology. A millionth of an inch error in the gyro axis of rocket navigation instruments makes the difference between a moon probe and a miss.

Dr. A. G. McNish, chief of the Metrology Division of the Bureau of Standards, said that increasing requests from industry for a source of talent to develop and use precise measurement techniques have resulted in an increasing load on the consulting services of the Bureau. Electronics and space industries, which feel the "measurement pinch" most acutely, have offered equipment, money, and their own employees for students in support of an academic center for metrology. Martin expects 50 employees to enroll.

"It is of the utmost importance to our needs at the Bureau that this center be established," Dr. McNish said. "There has been nothing like it before in the field of scientific measurement. The very security of our nation and the future vigor of science, industry, and commerce in America all depend on it."

The National Bureau of Standards cannot offer financial support, but it can offer the co-operation of its staff. Some courses will be given on NBS property by the staff. There will be laboratory work at the Bureau.

The lack of experienced people in the science of measurement is grave, Dr. McNish said. Today the NBS and many industrial companies are training people on the job. The military services have to do this. If they could get trained people, they could do the work for half the cost.

"During the past year," he said, "requests by industry and government for calibration of gage blocks alone have increased from 300 to 1000 monthly. Packing cases of important instruments of all kinds sent to NBS by industry for calibration are overflowing into the hallways of the Bureau.

"During the year ending June 30,

Metrology—the science of measurement. At George Washington University's School of Engineering it will soon be possible to sign up for a degree course in metrology. The equipment shown is the Leeds and Northrup K-3 potentiometer, with Wheatstone bridge. The console at the right is an ac/dc calibrator, also used to check voltages. These are the most accurate instruments of the kind now in industrial use.

1960, no fewer than 175,000 items of all kinds were sent to NBS. These ranged from electronics devices through optical instruments."

The day-to-day requirements of exact standards form a part of the quality control of the space industries. Testing equipment used in the manufacture of electronics equipment, for example, is in turn tested on machines in a central laboratory. Laboratory equipment is checked against equipment of the Bureau of Standards.

At George Washington University, when classes start in February, courses will include a fundamental course in metrology, a course on statistics as applied to measurements, and specialized courses such as electronic, thermal, and optical measurements. Those specializing in metrology will be required to take about 30 per cent of all their courses in this subject.

It is believed that other universities will undertake to establish similar centers if industry will indicate its support. They need the word from industry before going ahead.

New Electronic Student Desk developed by Williams Research Corp., Walled Lake, Mich., can replace a live teacher in many applications. Expert teachers, on sound, motion-picture screen, lecture and quiz student who must respond quickly by pushing answer buttons. He is automatically graded on adding machine-type tape at the right of the screen which also records answers as "correct" or "incorrect." Pushing the "true" button in a test quiz is Kay Nolan, 17, a senior at Grosse Pointe High School in suburban Detroit. The interested onlooker is a fellow student, David Rupp, 16.

EDUCATION

Electronic Student Desk

FOUR HUNDRED presidents, rectors, and vice-chancellors from universities in 70 countries found themselves in the shoes of students recently as they took their seats for the first public demonstration of a teaching desk during the International Association of Universities conference in Mexico City.

The distinguished delegates sat at the Williams Research "Science Desk" and received sound, motion-picture sample lessons in history, chemistry, and the French language over an intimate screen incorporated in each desk. As part of the lessons, each educator punched out answers to verbal questions from the motion-picture lecturer, and when he completed the test got his grades like any schoolboy, although in the modern way on an automatically marked paper tape.

The revolutionary new desk was developed over a four-year period by the Williams Research Corporation of Walled Lake, Mich. In announcing the development, Sam Williams, Mem. ASME, and president of the corporation, said it was designed to imitate a live teacher, but with one big improvement in an age of crowded classrooms, the ability to give individual attention and to allow the student to progress at his own rate.

Test questions are verbal or written; if written, the film stops at the question, continuing only after the student has punched his answer on the control panel. Then a flashing light advises him of the correct answer. It's cheat-proof, too.

Heat-Power Lab at Fenn

STUDENTS at Fenn College, Cleveland, Ohio, have an unusual opportunity to study and work with different types of steam-driven equipment and a boiler in the school's new heat-power laboratory, which has been in use since fall, 1959.

Six pieces of equipment—a turbine-driven 15-kw marine-type generator, a turbine-driven 5-kw generator, a shell-and-tube condenser, a direct-driven steam pump, a 5-hp vertical steam engine with Prony brake and dynamometer, and a turbine-driven 100-hp 220-volt dynamometer used as a generator—are steam-driven by a 100-hp water-tube boiler unit.

Arranged for firing with coal, gas, or oil, the specially designed boiler will generate steam at the rate of 3450 lb per hour at 160 psig and 600 F, and can be operated at pressures as low as 20 psig, with a temperature 20 F above saturation. Steady load conditions are maintained in the boiler, regardless of the equipment in use, by sending excess steam to the shell-and-tube condenser.

Students take instruction in the laboratory during two consecutive three-hour periods to get the full advantage of a day's boiler operation. First-period students get experience in start-up procedures before operating and studying the performance of the equipment taking the steam. Those in the second period learn shutdown procedures after completing their day's assignments. Indicators and recorders in the laboratory enable the students to learn how to take test data on the equipment with a high degree of accuracy.

U of Detroit Offers MS(Eng)

ADVANCED technology has completely outstripped the undergraduate engineering student.

"It is no longer practical," said University of Detroit administrators, "for a young man to 'become' a civil, mechanical, electrical, or aeronautical engineer after four years of college, and move directly into a research or allied technological job assignment.

"He must be educated as an 'engineer'

and learn his specialty after he reports for a job in industry.

"Even graduate studies can better provide him with advanced tools of mathematics, physics, and engineering science rather than attempt to school him in the rapidly expanding body of technical knowledge."

With this introduction the University of Detroit announced a new graduate program leading to a degree of master of science in engineering.

The program will emphasize advanced physics, mathematics, and engineering science.

"This is a considerable departure from the traditional structure of advanced studies in a majority of graduate schools of engineering in the United States," according to Clement J. Freund, Fellow ASME, dean of the U. of D. College of Engineering.

"Instead of offering degrees in the specialized branches of subject areas, this program is unified and to a degree comprehends all the special branches of engineering.

"The trend in modern engineering is to blend the various branches of engineering and to form a closer alliance with basic science.

"Thus, in this program, advanced courses in physics, mathematics, and engineering science form the major area of study.

"These courses provide a substantial foundation for specialized courses and research in mechanical, electrical, civil, and aeronautical engineering."

The program began this Fall and offers three study plans:

A full-time schedule over a three-semester, year and-a-half period.

A half-time schedule, day or evening, taking twice as long but permitting the student to continue full-time employment.

An "interrupted study" program with the student alternating semesters of work and study for three years.

Reactors—Educational

A NEW research reactor at the U. S. Atomic Energy Commission's Puerto Rico Nuclear Center on the Mayagüez campus of the University of Puerto Rico, achieved initial nuclear operation (criticality) on August 16, as announced by John S. Graham, acting chairman of the commission. The new pool-type reactor, which was dedicated August 23, has its core suspended from a movable bridge, and thus operable in either of two sections of the 49-ft-long water-filled concrete pool. It also uses new type fuel elements. It will be used primarily in connection with the center's nuclear science and engineering program, an 11-month graduate course that leads to an MS in nuclear technology.

Library

DR. V. D. SALERNO, Mem. ASME, Dean of the College of Science and Engineering of Fairleigh Dickinson University, has announced that the Atomic Energy Commission has granted the university a current depository library collection. It will be placed in the Teaneck Campus library, which will service 4000 reports, foreign and domestic, per year.

Campus Data

MORE expansion plans for Newark College of Engineering, as announced by the board of trustees, may materialize by 1965 into four new buildings and athletic and parking facilities; and six additional buildings by 1975. This is part of an expansion project begun in 1950 that is expected to increase NCE's total area from its present two acres to a 27-acre campus.

Better Teaching of Engineers

THE College of Engineering and Architecture of The Pennsylvania State University held an institute on effective teaching for young engineering teachers from Aug. 29 to Sept. 9, 1960, on the University Park campus. It was given under the auspices of the American Society for Engineering Education and the Engineers' Council for Professional Development. It was supported by a grant from the Ford Foundation. Teachers from 50 universities attended as group leaders or participants, including 25 young engineering teachers with one to three years' experience (known as YETS) and ten mature engineering teachers (METS) with 10 or more years of teaching experience.

Purposes of the institute were: To provide training in the fundamental principles and use of effective teaching methods; to orient young teachers to their professions as educators; to encourage research in methods to improve learning. It is hoped that the YETS and METS will serve as a seeding force to broaden discussion on these purposes in their own institutions. The METS plan to institute training programs as well.

During the discussions it was brought out that profound improvement can come from such evaluation techniques as measuring student response to instruction, allowing the instructor to monitor tape recordings of his classes, putting an experienced teacher in the classroom with a young instructor, and through subjective opinion and research on the characteristics of successful teachers.

The need for lesson, course, and curriculum planning was likened to the need for blueprints to engineer product.

"Intuitive planning and operation" is insufficient to present today's engineering curriculum.

In addition to day and evening sessions, informal groups met for consideration of such matters as classroom creativity and climate, restoration of good teaching along with research as a proper basis for promotion, the threat of depersonalization as enrollments increase, the shift from emphasis on purely mechanical skills to intellectual skills, and the need to turn out not just an engineer but a whole man who would grow in service and accomplishment throughout his life.

The new Heat-Power Laboratory of Fenn College, Cleveland, Ohio, provides for instruction in boiler operation as well as study and testing of steam-powered equipment such as that on the **right.** The temperature of steam taken by this equipment from the desuperheater is held at 600 F by a Copes-Vulcan indicating temperature controller (over Prony brake scale) having both proportional and reset bands.

MEETINGS OF OTHER SOCIETIES

• IN THE UNITED STATES

November 15–17

IRE, Northeast research and engineering meeting, Boston, Mass.

November 16–17

Industrial Wastes Conference, Oklahoma State University, Stillwater, Okla.

November 16–19

Society of Naval Architects and Marine Engineers, annual meeting, Waldorf Astoria Hotel, New York, N. Y.

November 29

American Institute of Consulting Engineers, annual dinner, Waldorf Astoria Hotel, New York, N. Y.

November 30–December 2

American Institute of Mining, Metallurgical and Petroleum Engineers, electric furnace conference, Morrison Hotel, Chicago, Ill.

December 1–2

IRE, vehicular communications meeting, Sheraton Hotel, Philadelphia, Pa.

December 4–7

AIChE, annual meeting, Statler Hotel, Washington, D. C.

December 5–8

American Rocket Society, annual meeting and astronautical exposition, Shoreham Hotel, Washington, D. C.

December 11–14

Eastern Joint Computer Conference, New Yorker Hotel, New York, N. Y.

December 12–15

Industrial Building Exposition and Congress, Coliseum, New York, N. Y.

• IN EUROPE

November 30–December 2

Iron and Steel Institute, symposium on steels in reactor pressure circuits, London, England.

(*For ASME Coming Events, see p. 124.*)

I. MECH. E. MEETINGS

November 9–10

The Use of Secondary Surfaces for Heat Transfer With Clean Gases, symposium, apply for registration at The Institute, London, England.

January 18, 1961

Pressure Vessel Research Toward Better Design, symposium, apply for registration at The Institute.

March 1, 1961

User Experience of Large-Scale Industrial Vacuum Plant, symposium, London.

→*Note:* The foregoing calendar of The Institution of Mechanical Engineers (Great Britain) meetings is published as a service to members of ASME. Further information relating to complete programs and available papers may be obtained from The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S. W. 1, England. Preliminary programs also are published in *The Chartered Mechanical Engineer* (I.Mech.E.) which is on file in the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y., and other libraries throughout the United States and Canada.

LITERATURE

ASME Issues Two New Books

"Pressure Vessel and Piping Design," a monumental collection of fundamental information for designers of boilers, pressure vessels, and piping systems has been published by The American Society of Mechanical Engineers. In 700 pages, divided into ten sections, it deals with openings, bolted-flanged joints, heads, shells, piping, materials and fabrication, thermal stress and fatigue, loads and supports, external pressure, and miscellaneous topics. A committee of specialists compiled the book from technical reports published between 1927 and 1959. Copies are available at $10 each from the Order Department, ASME, 29 West 39th Street, New York 18, N. Y.

Another book, "Friction and Wear in Machinery," containing 15 papers on various aspects of the subject, is the latest available volume of a series published annually over the past several years by the USSR Academy of Sciences through its Institute for the Science of Machines (Institut Mashinovedeniia). Translated from the Russian by the ASME Research Committee on Lubrication, it covers a wide range of topics from hydrodynamic lubrication and bearing performance to boundary lubrication, dry friction, and wear. Also included is the Russian alphabet and a list of Russian abbreviations, with transliterations for both, and an extensive bibliography on foreign and domestic literature published in the field for 1954–1955. The 334-page book costs $7.50, and is obtainable from the Order Department, ASME, 29 West 39th Street, New York 18, N. Y.

New Books

High Temperatures. "Proceedings of an International Symposium on High Temperatures" reports in detail the results of the conference on high-temperature technology organized by Stanford Research Institute held recently in California. The findings of today's high-temperature research, their applications, and their potentials are brought together in this 348-page book. Available at $15 a copy from McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y.

Industrial Safety. The National Safety Council has announced the publication of an "Accident Prevention Manual for Industrial Operations," a 1542-page, fourth edition of a book described as the most complete and informative safety reference work in existence. Included are new chapters on the hazards of handling radioactive materials, nondestructive means of testing materials and products through radiography, and various kinds of radiation and safe limits of exposure. Priced at $15.50 for single copies, $14.75 for two to nine copies, $14 in quantities of 10 to 99, and $13.20 for 100 or more, it is available from the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

Research Scientists. What makes researchers tick is the subject of "The Characteristics of Engineers and Scientists," a 136-page book by Lee H. Danielson of The University of Michigan School of Business Administration. His findings and recommendations are based on interviews with executives, supervisors, and nonsupervisory professionals in ten well-managed firms with extensive research organizations. He shows changes in the characteristics of engineers and scientists in industry and their relations with management. Available from: The University of Michigan Bureau of Industrial Relations, Ann Arbor, Mich., at $4 a copy.

Die Design. "Manual of Instruction for Die Design," by A. A. Vezzani, associate professor of vocational education and practical arts at The University of Michigan, has been published by the American Society of Tool and Manufacturing Engineers. The manual, designed to be used in conjunction with "Die Design Handbook," which ASTME compiled five years ago, is a 210-page work covering the use, construction and design of blanking, compound, forming, combination, progressive, draw, trim, and cam dies. It also contains infor-

mation on presses and their selection, on die materials and equipment, safety, production factors, and costs.

AWS

● The American Welding Society has announced the availability of the 1959 supplement to the AWS Bibliographies. It contains listings of all articles appearing in the *Welding Journal* from January through December, 1959. Available from the American Welding Society, Department T, 33 West 39th Street, New York 18, N. Y., at $1.50 a copy.

● The third section of the fourth edition of the "Welding Handbook" has been published. The 512-page volume contains information on special welding and metal-joining processes, arc cutting processes, adhesive bonding, welding of plastics, and ultrasonic welding. Available from the American Welding Society, 33 West 39th Street, New York 18, N. Y., at $9 a copy.

Government Publications

The following publications, issued by the Bureau of Mines, are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

● "Bibliography on Metallurgy of High-Purity Tungsten, January 1911 through February 1959" contains references that concern methods of improving the purity of tungsten, from processing the ore to treating the finished metal. The publication describes 262 articles, books, and patents. Order Information Circular 7953 for 35 cents a copy.

● A new, 1000-page edition of "Mineral Facts and Problems," an encyclopedic reference on metals, nonmetals, and mineral fuels, and the industries that produce them, covers history, technology, and uses of the nation's minerals, and describes recent advances in mineral development. Among new developments mentioned are electronics, atomic energy, zirconium, missiles, and space exploration. Order Bulletin 585 at $6 a copy.

Russian Reviews. A weekly review of scientific and technical articles appearing in the Soviet press and of significant new Russian books is now being published. Called *Current Review of the Soviet Technical Press* (Order No. 60-21441), it covers articles in many fields of science and technology, including metals, ceramics, electronics, use of ultrasonics, mechanical engineering, aviation, radioactivity and radiation in industry, oceanography, meteorology, and activities in space. Subscription available at $7 for six months ($2 additional for foreign mailing) from: Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

AEC. "Safety Analysis of Enriched Uranium Processing" (NYO-2980), represents results of a study conducted to provide basic information and to evaluate the potential hazards involved in the processing of unirradiated, enriched uranium in AEC-licensed commercial plants. The potential sources of nuclear accidents, the range of possible excursion magnitudes, and the possible consequences in terms of the extent of the radiation hazards from direct nuclear radiation and the dispersal of radioactive fission products are considered in the report.

Available from: Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., at $3 a copy.

The first two volumes of eight volumes that together comprise Part III of the Commission's four-part study of the Civilian Power Reactor Program have been published and are available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

● "Status Report on Boiling Water Reactor Technology as of 1959," TID-85818 (5), Book 5, includes 75 pages of information related to an evaluation of the technological and economic status of boiling water reactors. The price is 60 cents a copy.

● "Status Report on Organic-Cooled Power Reactors as of 1959," TID-8518 (7), Book 7, includes 69 pages of information related to an evaluation of the technological and economic status of organic-cooled power reactors. The price is $2.25 a copy.

NSF

● "Statistical Handbook of Science Education" (NSF-60-13), a compilation of statistical material on the education and training of scientists and engineers in the United States, has been published. The major parts of the publication first deal with human-resources data—population, educational levels of the population; college degrees awarded, qualifications of teachers; second, with institutional and financial data—number and types of school, expenditures, tuition costs, financial aid; and third, with general appendix tables containing more detailed information on all these subjects. Copies available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. at a price of 55 cents.

● A "List of Russian Scientific Journals Available in English" is being published by the NSF Office of Science Information Service, Washington, D. C. The publication lists the journals which have been translated together with subscription prices and names and addresses of sponsoring societies or agencies. It also lists other societies which are sources of translated bibliographies and abstracts of Russian scientific literature.

Soviet Physics

"Soviet Physics—Technical Physics," a translation of the USSR Academy of Sciences monthly, *Zhurnal Tekhnicheskoi Fisiki*, is being published by the American Institute of Physics. Plasma phenomena, magnetohydrodynamics, and electron and ion optics are research areas covered in this publication which contains Soviet articles published five to seven months before the English language issue. Available from the American Institute of Physics, 335 E. 45th Street, New York 17, N. Y. at $55 for Volume 5 containing the material published in the original Russian journal in 1960 ($25 for libraries of nonprofit academic institutions). Volume 4 containing material published in the original Russian journal in 1959 is available at $96.

Management

● The "Second Top Management Seminar Proceedings" are available. The publication, which includes articles on management controls, management development, management and research, and stimulating creativity, can be obtained from: H. B. Maynard and Company, Inc., 718 Wallace Ave., Pittsburgh 21, Pa., at $10 a copy.

● "Teamwork in Technology: Managing Technical Manpower" is the title of a study of employment and utilization practices of the engineering technician. Included are chapters on training, relation to collective bargaining, hiring and administrative practices in industry and government, and attitudes of technicians.

Prepared by a group of Harvard University's Graduate School of Business, the 172-page report is available from: P. O. Box 158, Scarsdale, N. Y., at $18.50 a copy.

Foreign Publications

● "Proceedings of the International Clean Air Conference" is a bound volume containing the 78 papers presented for discussion at the 1959 London conference recently published. Available at £1 10s. a copy plus 2s. 6d. postage from: The National Society for Clean Air, Palace Chambers, Bridge Street, London, S. W. 1, England.

MHD at Winter Annual Meeting

MAGNETOHYDRODYNAMIC (MHD) generation of electricity, the infant of today with such great potential as a teenager, promises to set attendance records at the coming Winter Annual Meeting of The American Society of Mechanical Engineers scheduled for Nov. 28–Dec. 2, 1960, at the Statler Hilton Hotel, New York City.

The Fuels Division of ASME, a specialization group devoted to the promotion of mechanical engineering in all fuels which are used to produce heat or power by combustion, announces sponsorship of four separate sessions during the Winter Annual Meeting.

Highlighting these sessions will be three papers by pioneers in MHD, the "glamour" electric generation process using high-temperature, highly ionized gases passing through a magnetic field.

Sharing interest headlines with MHD is a panel discussion covering Furnace Safeguards. Eleven panelists from representative manufacturers and electric utilities will present their viewpoints on automatic flame safeguard effectiveness in an attempt to find a common ground from which further development toward full automation can progress. Panel discussions cover areas such as standards for purging, use of flame scanners, automation checks of firing cycle, TV for furnace observation, relation of firing system to explosion potential, and other related items.

The Monday morning session will present two papers under the general heading of Fuels Handling and Preparation which will be of particular interest to operating and management personnel in the special fields which are covered as indicated by the paper titles.

The Tuesday morning session offers two papers relating to gaseous products of combustion in furnaces which will have attention from operating personnel as well as designers of furnaces and attendant equipment.

INDUSTRIAL FILMS

Space Vehicles

A 16-MM, filmed lecture series, "Ballistic and Space Vehicle Systems," has been produced by the University of California, Los Angeles, Calif. Designed to supply fundamental and latest research and development information on which to base a systems engineering approach, the series presents an over-all systems analysis to help solve interface problems of ballistic and space vehicles.

It consists of 21 lectures which are divided into 15 programs with a total running time of approximately 28 hours. Available for rental in its entirety for $2500 from the Department of Visual Communication, UCLA Extension, University of California, Los Angeles 24, Calif.

Palletless Handling

"CASED Goods Handling With the Cart-N-Grab" is a new industrial motion picture showing how Hyster Company's lift trucks with Cart-N-Grab clamps have increased handling efficiency. The 11½-min color film reveals how the cost of handling cased and cartoned goods can be substanially reduced through use of a new lift-truck attachment which eliminates the need for pallets. For information write Hyster Company, P. O. Box 847, Danville, Ill.

Fork Trucks

Two 20-min sound and color slide films have been made by the Industrial Truck Division of Clark Equipment Company.

Uses and advantages of "Ranger" forklift trucks of 4000 and 6000-lb capacity, especially designed for rugged outdoor operations, are shown in "Anything, Any Place, Any Time."

"Profile of a New Concept" explains how long wheel base and proper weight distribution contribute to maneuverability and driver comfort. It shows design concepts and how they benefit users of 2000 to 5000-lb capacity gas-powered Clark lift fork trucks.

Each film may be obtained from: Slide Film Department, Industrial Truck Division, Clark Equipment Company, Battle Creek, Mich., without charge.

Ernst W. Allardt, **left,** past Vice-President of Region V, was recently honored at Canton, Ohio, for his outstanding work in behalf of the United Engineering Center Building Fund. Region V was the first to go over the top in the Member-Gifts Campaign. With Mr. Allardt are Walker L. Cisler, **center,** President of ASME, and Henry N. Muller, current Vice-President of Region V.

At the Canton, Ohio, meeting which honored Mr. Allardt, recognition was also paid to Myron R. Bowerman, Fellow ASME, and director of research for Alliance Machine Company, for his 50 years of membership in the Society. **Left to right:** Mr. Allardt, Mr. Bowerman, and R. F. Iager, Vice-Chairman of the Executive Committee of the Canton-Alliance-Massillon Section of Region V.

Bright Spots on the Member Gifts Front

Signs of progress in the Member Gifts Campaign came from two Sections, Inland Empire and San Francisco. Inland Empire (Montana, Eastern Washington, and Idaho) moved from 99 per cent of quota to 101 per cent for final victory, raising the total number of Sections that have surpassed their quotas to 24.

Substantial progress was also reported by San Francisco, which raised nearly $2000 during September, cutting the remainder needed to $15,520. This substantial gain is traceable largely to the efforts of Ernest Chilton at Stanford Research Institute who kept the returns flowing steadily through September.

His secret of success: "Personal contact. That is the key. We found that members were quite willing to give when a volunteer called on them at their place of business and asked in person for a pledge. Actually, the real credit belongs to the area captains. Here in the San Francisco Section, we cover a large geographic area. Therefore, when we began this renewed drive, we divided our Section into 14 areas, each in the charge of an area captain. They are a remarkable group of men and since they are doing the work, credit for what we have achieved belongs to them and to the members who are contributing."

Mr. Chilton's immediate plans: Another $1000 toward the remaining goal of $15,500, before the end of October.

Gulf Coast Section also reported progress during the month with another 15 per cent added to the total, bringing the Section's score to date to 75 per cent of its total goal.

New Target for 72 ASME Sections

With the summer doldrums over, in the ASME Member Gifts Campaign, there is a new target for the Member Gifts Campaign: Progress in every Section, every month, until every Section goes over the top.

As of September 30, 72 Sections had not reached their goal. About two thirds of these have reported no substantial progress in recent months.

Get Your Section off the List

A list of Sections that have not reached their quotas, along with percentage achieved to date, and dollars left to be obtained is on this page. See if your Section is there. If it is, make sure that it does not stay in hibernation. Get the Campaign going. Get your Section up higher on this list this month and off the list by next month.

If you have not yet made your contribution, call your local Chairman and tell him to come and get it. Offer to call on a few members for their gifts. Let's make our organization alive. It's a challenge as well as a chore, but it's something we can do if we all pitch in. It's our profession and it's our building. Let's be proud of it.

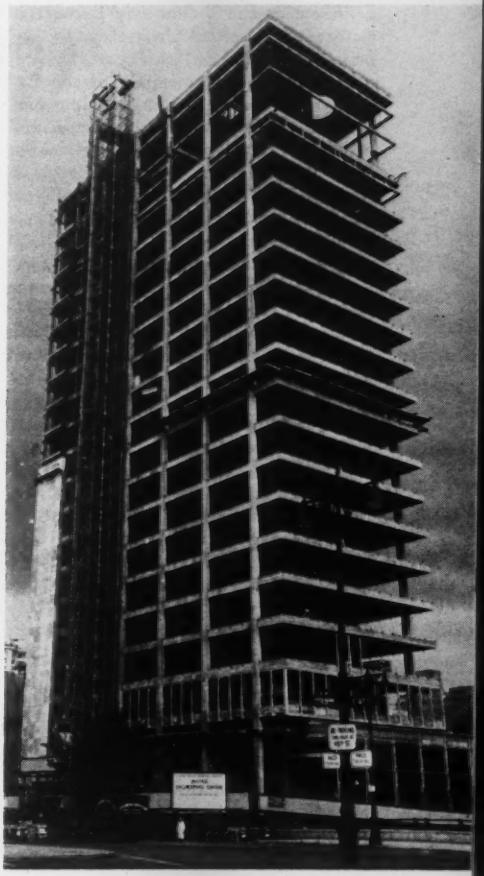
Let's finish the job!

▼ Your Section's Score as of Oct. 1, 1960

Per Cent of Quota	SHORT OF QUOTA Section	Dollars Short of Quota ▼
97.8	Erie	97
91.1	Sabine	208
90.2	North Alabama-Mississippi	230
74.7	Gulf Coast	471
87.0	Rock River Valley	514
83.1	Iowa-Illinois	655
68.6	New London	717
95.5	Cleveland	735
84.0	Piedmont-Carolina	760
79.3	Mid-Hudson	803
71.5	Nebraska	833
93.9	Milwaukee	869
90.4	Fairfield County	900
27.6	Paducah	970
53.6	Utah	985
85.2	Rochester	1,007
66.4	Central Savannah River Area	1,023
39.6	Miami	1,051
8.3	Palm Beach	1,100
55.2	Central Michigan	1,119
87.1	Anthracite-Lehigh Valley	1,141
42.4	Greenville	1,232
70.9	Susquehanna	1,233
42.5	Central Kansas	1,264
46.6	Idaho-Montana	1,292
85.2	Minnesota	1,315
29.6	Savannah	1,324
40.4	Mexico	1,336
32.5	Mohawk Valley	1,403
82.2	Columbus	1,405
57.1	Eastern Virginia	1,408
67.0	Toledo	1,504
83.9	Kansas City	1,574
0.9	North East Florida	1,585
64.6	Syracuse	1,690
43.4	Oregon	1,790
56.0	New Haven	1,823
	MORE THAN $2000	
53.1	Arizona	2,034
71.1	Akron	2,051
79.7	Delaware	2,093
62.4	East Tennessee	2,103
22.1	Central Pennsylvania	2,150
91.1	Pittsburgh	2,172
50.5	Western Massachusetts	2,336
24.8	Eastern North Carolina	2,360
56.8	Central Illinois	2,557
15.6	Central Virginia	2,719
24.4	Virginia	2,919
18.3	St. Joseph Valley	3,054
23.7	Louisville	3,127
34.1	Florida	3,139
42.9	New Mexico	3,515
58.5	Western Washington	4,007
14.5	Northern New England	4,310
17.6	Chattanooga	4,584
62.6	Baltimore	4,986
	MORE THAN $5000	
30.5	Rocky Mountain	5,004
34.8	Buffalo	5,095
52.1	St. Louis	5,382
24.0	New Orleans	6,309
35.6	Mid-Continent	6,802
34.2	Ontario	6,901
37.1	Hartford	7,529
53.2	Mid-Jersey	7,828
41.8	South Texas	8,865
24.7	North Texas	9,407
34.6	Washington, D. C.	9,625
59.7	Boston	11,986
69.6	Chicago	13,129
49.7	San Francisco	15,520
54.8	Philadelphia	19,483
29.8	Los Angeles	35,868

United Engineering Center

On October 6, Indiana limestone sheathing the southwest corner of the United Engineering Center had risen as far as the twelfth floor. Completion is scheduled for mid-1961.



Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

ASME Technology Executives Meet at Sterling Forest

Publications and Summer Annual Meeting Discussed at TEC Briefing

THE eighth Technology Executives Conference of the ASME was held at Sterling Forest, Tuxedo Park, N. Y., Oct. 2–4, 1960. That is the annual conference in which the men who will lead the Society in the following year meet for their briefing and for discussions of policy. This report is for members of the Society who would like a glimpse behind the scenes.

Present at the Technology Executives Conference were the newly elected members of the Council, the new Division chairmen, the new members of the Executive Committee of the Divisions, the Secretary of the Society, the Editor, and other staff members representing technological services.

Sterling Forest is an area north of New York City which is being developed as a combination recreation and industrial park (Union Carbide already has a research center functioning within the development). Facilities are available for just such conferences as ASME's TEC, near the city yet remote, a place to get things done.

Basic Briefing

The basic briefing covered the Society's organization chart—who's responsible for what—and the interrelationship between the Professional Divisions and the geographical regions. ASME divides the country into Regions, each with its Vice-President, and the Regions in turn contain Sections, all to serve as convenient focal points for meetings of the membership. Wherever you live and perform your engineering, you are in one of the regional groups, and probably within the boundaries of one of the Sections. (See MECHANICAL ENGINEERING, August, 1960, pp. 118–119.)

More recent in the Society's development have been the Professional Divisions which cut across all geographical boundaries, and bring together those members interested in one particular phase of mechanical engineering. As a member, you have named three of these Divisions—as, for example, Gas Turbine Power, Heat Transfer, Lubrication—as the fields in which you are most interested. Regardless of what Region you live in, you receive the notices of the Conferences of your three Divisions, wherever those Conferences may be held.

Question: On what ground do Sections and Divisions meet, and what are the responsibilities of one to the other? For example: If the Production Engineering Division wishes to hold a Conference in, say, St. Louis, what part do each of the two groups play in arranging the Conference? How far ahead must each be notified of the intentions of the other? Who is responsible for the hotel arrangements? How are finances arranged?

Over the years, a tremendous body of experience has been built up to guide the Society in these areas. This experience preserves its continuity through the permanent staff, headed by the Secretary of ASME, and must be passed along to the newly elected officers in the field. This is the primary purpose of the Technology Executives Conference.

If It Isn't One Thing, It's Another

But new problems continually arise. Example: As the Divisions grow in importance, and as each of the now 24 Divisions takes to holding an annual conference of its own, the general meetings (in which all Divisions may participate) lose attendance. Members want to attend the biggest meeting of them all, the Winter Annual, in November; and each member wants to attend the annual conference of his "number-one" Division. How many more meetings can members afford to attend? What should be done about the Summer Annual Meeting, which, in recent years, has failed to attract enough technical papers . . . or even a large enough attendance?

By the Society's Constitution, one of its two Business Meetings is to be held at the June Summer Annual Meeting (the other at the November Winter Annual Meeting). Along with the Business Meeting, there customarily has been a meeting of the full Council, the Nominating Committee, the Regional Delegates Conference—and any other meetings pertaining to the administrative business of the ASME. At Sterling Forest, it was suggested that the Summer Annual Meeting be replaced, eventually, by a "Committee Week," in which committee meetings that would normally take place in the spring and early summer—and some that would be moved from the Winter Annual—be concentrated at one place during one week, concurrent with the Business Meeting. Thus, even though there were no technical sessions, there would be sufficient members present to provide the necessary quorum to ratify the actions taken in the Business Meeting, and the committee work of the Society would proceed more efficiently.

What's all this committee work?

It may surprise you to know that there are about 5000 committee posts held by the members—and certain nonmembers—serving the Society. Besides committee work for Regions, Sections, and Divisions, with which you are familiar, there are the committees on codes and standards, such as the ASME Boiler and Pressure Vessel Codes, Power Test Codes, Elevator Codes, and others. There are many who feel that ASME's greatest contribution to engineering has been its work in codes and standards.

Then there is research. If you are not familiar with the Society's place in research, you are not alone. There were men at Sterling Forest who needed briefing on this activity.

In research, the Society plays a promotional role. It does not own or

operate any research laboratory, but it does sponsor projects believed to be of value to the profession, projects which individual companies do not feel economically justified in undertaking. A project is proposed, and if it appears to be a proper one for ASME sponsorship a special research committee is formed, funds are solicited from industrial sources (no one company assuming the whole burden), a contract is signed with a research laboratory, and results are published. That last is important: Results are published.

Example: Every designer of equipment for steam at high pressures and temperatures relies on the steam tables which ASME sponsored.

In practically every case of Society-sponsored research, the ASME contribution is greater than the mere collection and administration of funds. Men, materials, instruments, and sometimes laboratory space are made available by members, and these may exceed the solicited funds in importance.

Deadlines, Deadlines

Publication of technical papers is a basic obligation of the Society. A fact not generally understood is that more than 800 technical papers will have been presented at the various meetings and conferences, this year, and that it is economically impossible to print all the papers in the *Transactions* quarterlies or MECHANICAL ENGINEERING. Even if it were desirable to print all of them, it would not be possible to find skilled staff to handle this mountain of editing—even if this and other costs did not make such a project out of the question. Even with available staff the work must be spread out, not done in spurts. This is one of the reasons why deadlines must be respected.

The man who carries the ultimate responsibility for decisions on papers is the Editor who applies editorial discretion in the face of many pressures. This authority is delegated to him by the Publications Committee. Executives gathered at Sterling Forest were warned not to promise publication to authors, promises which might not be possible of fulfillment.

Editorial decision reaches its most difficult level in the placing of articles in MECHANICAL ENGINEERING. By condensing every paper—by hardening the writing until there is scarcely a wasted word, and by elimination of those formal repetitions (opening, reiteration, conclusion) which are normal in the usual engineering report—the staff gets as many as eight feature articles into an issue. That means a possible maximum of 96 articles in a year, somewhat more than one paper out of ten.

How are the decisions made? For the magazine, a paper must be of "immediate" interest, something that engineers will talk about over the table at gatherings of the clan. It must be of "general" interest, something that will claim readership from every branch of the profession, something they will all want to know about. When a member has read every issue of MECHANICAL ENGINEERING during the year, he should be well informed on developments in all phases of mechanical engineering; he should have seen something from every active Division of the Society. He should be able to hold up his end of the conversation in any group of mechanical engineers, anywhere.

Engineering Management Conference Explores Future of Management

THE eighth annual Engineering Management Conference took place Sept. 15–16, 1960, at the Morrison Hotel, Chicago, Ill. It was sponsored by eight leading engineering societies. They are: The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Industrial Engineers, Inc., the American Institute of Mining, Metallurgical and Petroleum Engineers, Inc., the American Society of Civil Engineers, the Engineering Institute of Canada, the Institute of Radio Engineers—all with the co-operation of their local Chicago sections—and the Industrial Management Society. The theme: "Managing Tomorrow."

A booklet containing the proceedings of this conference—the papers delivered, and Luncheon and Banquet addresses—has been published by the American Institute of Electrical Engineers, 33 West 39 Street, New York 18, N. Y., and may be ordered from them for $2.50.

Four Basic Areas

The conference, planned for managers of technical work, or those preparing for such management positions, was divided into four sessions, covering four basic areas of inquiry.

First, a session on "impinging forces," those influences that will shape tomorrow's management decisions. Ralph Burgess, chief economist for American Cyanamid, spoke on the economic forces shaping business policy. E. I. Green presented a paper on the impact of technological progress on management. C. C. Furnas, Mem. ASME and chancellor, University of Buffalo, spoke on the social and political forces—who really makes the decisions, and why?

At the Luncheon, between the first and second sessions, C. H. Linder, president, AIEE, Mem. ASME, and vice-president and group executive of General Electric, delivered an address entitled "Making the Committment to Change." Mr. Linder spoke from notes, and his speech is not available in the AIEE booklet. He made the point that the answer to competition from any source—including technology itself—is timely innovation. Innovation demands skill at knowing what is feasible, and what is wanted. It demands ability at decision making, including the choice of objectives, the planning and organizing of effort, and the measurement of results.

At the second session, covering new requirements and new aids for managers, J. S. Sayer, general manager of Documentation Incorporated, spoke on the mobilization of data and information for management decisions. He illustrated with specific examples something of the present state of the art of data processing. W. A. Smith, Jr., director of the computing laboratory of Lehigh University, discussed the relationship between engineers and computists. Both must focus on their common interest, mathematical analysis of a problem, but the computist must furnish guidance in recognizing the utility of the computer.

The use of statistics as an aid to engineering was clarified in a paper by H. L. Jones, professor of statistics in the Graduate School of Business, University of Chicago. There is a never-ending cycle of redesign, reprocess, and resell in order to keep abreast of consumers' changing needs and buying habits. Statistical procedures are important aids in each of the three phases of this cycle.

The Banquet

At the banquet, held on the first night of the conference, the main speaker was Peter F. Drucker, professor of management at the Graduate Business School, New York University, and distinguished author and consultant. Among several interesting observations made by the famous writer on management was the point that we can no longer be guided by "that impersonal something called 'the market.'" Management must foresee the changes in the economy, anticipate what should be manufactured—and how much.

He said: "What . . . underlay (the old) approach was the failure to see the constant change in the economy, the failure above all to see the impact and importance of innovation, that is of the purposeful and intentional act of changing the economy and the society and, with them, the economic characteristics of the individual enterprise . . ."

At another point Professor Drucker said: "There is a tendency, today, to argue whether the 'manager' or the 'individual professional' is more important. There is even a tendency to argue which comes first. This is a stupid argument. The two need each other, depend on each other. The effectiveness of the manager depends on his ability to focus the vision, energies, and knowledge of these individual professionals on common performance toward common results. By the same token, the effectiveness of the individual professional depends on his ability to learn the general meaning of his specialized work. He depends on something which only the manager can contribute, without which he is wholly unproductive."

This impact of management on professional people came in for discussion on the second day of the conference. H. F. Smiddy, Mem. ASME and vice-president management consultation services of General Electric, spoke on the engineer's participation in the company and in the community. It is his belief that the "organization" does not stifle individual initiative, individual growth. Rather it gives him a sense of direction.

"A sense of direction," he said, "is increased to the extent each individual works as part of the organization—from within, rather than as a tentative, outside observer."

H. A. Shepard, professor of behavioral science, Case Institute, took up the social change in science and engineering. What are the engineers bringing down on their heads? To what new heights are their actions raising them? And what are the implications of these changes for the men who manage engineering?

The Years Ahead

At the second day's Luncheon, Gerry E. Morse, vice-president of Minneapolis-Honeywell, spoke on engineering management in the years ahead, examining the problem of turning the engineer into a manager. One of the factors he brought out is that a manager is condemned to face hostility, but that the more he understands the work—the more decisions he can make on a basis of technical understanding rather than

(*Continued on page 134*)

ASME COMING EVENTS

November 27-December 2
ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

March 5-9, 1961
ASME Gas Turbine Power Conference and Exhibit, Shoreham Hotel, Washington, D.C.

March 12-16, 1961
ASME Aviation Conference, Statler Hilton Hotel, Los Angeles, Calif.

March 16-17, 1961
ASME Textile Engineering Conference, Clemson College, Clemson, S.C.

April 6-7, 1961
ASME-SAM Management Engineering Conference, Statler Hilton Hotel, New York, N. Y.

April 9-13, 1961
ASME Oil and Gas Power Conference and Exhibit, Jung Hotel, New Orleans, La.

April 10-11, 1961
ASME Maintenance and Plant Engineering Conference, Bancroft Hotel, Worcester, Mass.

April 23-26, 1961
ASME Metals Engineering Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

May 7-10, 1961
ASME-EIC Hydraulic Conference, Queen Elizabeth Hotel, Montreal, Que., Canada

May 10-12, 1961
ASME Production Engineering Conference, Royal York Hotel, Toronto, Ont., Canada

May 22-25, 1961
ASME Design Engineering Conference and Exhibit, Cobo Hall, Detroit, Mich.

June 11-15, 1961
ASME Summer Annual Meeting, Statler Hilton Hotel, Los Angeles, Calif.

June 14-16, 1961
ASME Applied Mechanics Conference, Illinois Institute of Technology, Chicago, Ill.

August 28-September 1, 1961
Second International Heat-Transfer Conference, University of Colorado, Boulder, Colo.

September 14-15, 1961
ASME-AIEE Engineering Management Conference, Hotel Roosevelt, New York, N. Y.

September 24-27, 1961
ASME Petroleum Mechanical Engineering Conference, Muehlebach Hotel, Kansas City, Mo.

October 4-6, 1961
ASME Process Industries Conference, Shamrock Hilton Hotel, Houston, Texas

October 17-19, 1961
ASME-ASLE Lubrication Conference, Morrison Hotel, Chicago, Ill.

November 26-December 1, 1961
ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

(*For Meetings of Other Societies, see page 118.*)

Note: Persons wishing to prepare a paper for presentation at ASME National meetings or Division conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price to nonmembers, 50 cents; to ASME members, free. Also available on request is a "Schedule of Program Planning Dates for Meetings and Publication Deadline Dates." Ask for Form M&P 1315.

ASME Elects New Officers by Letter Ballot

For the election of 1961 officers, as reported by the tellers Frank P. Berganzi, William Kowalsky, and R. S. Touma, letter ballots received from members of The American Society of Mechanical Engineers were counted on Sept. 27, 1960.

The total number of ballots cast was 13,118; of these 81 were thrown out as defective.

	Votes for	Votes against
For President		
William H. Byrne	12,971	66
For Regional Vice-Presidents —serve two years		
George B. Thom	13,006	31
Roy C. Robertson	13,010	27
Donald J. Bergman	13,014	23
Eaton H. Draper	13,011	26
Allen H. Jensen	13,010	27
For Regional Vice-President —serve one year		
Harold Grasse	13,014	23
For Directors —serve four years		
James B. Jones	13,012	25
Rolland S. Stover	13,014	23

The new officers will be introduced and installed during the 1960 ASME Winter Annual Meeting to be held at the Statler Hilton Hotel, New York, N. Y., November 27 to December 2, 1960.

Biographical sketches of the newly elected officers were published in the August, 1960, issue of MECHANICAL ENGINEERING, pp. 122–127. ASME Annual, AC-10, published each year, contains complete lists of officers and personnel composing the Council, Boards, and Committees of the Society.

deLesseps S. Morrison, **left,** Mayor of New Orleans, presents Harold Grasse, Vice-President, ASME Region VIII, with gold key and certificate of official welcome

Creativity Panel discussion leaders, **left to right, standing,** D. L. Shuker, Art Wintringham, and R. E. Schlorff. **Seated,** R. L. Nall, Joe Parrish, and S. L. Collier. Jack Hayden arrived too late to be photographed.

E. W. Jacobson, **right,** of Gulf Research and Development Company accepts a $1000 check from A. F. Rhodes, vice-chairman, Petroleum Division Executive Committee, for the United Engineering Center presently under construction in New York City.

15th ASME Petroleum Conference in New Orleans Thoroughly Examines Fields for Greater Productivity

- **ASME Petroleum Division contributes second $1000 toward UEC Building Fund**
- **Seek creativity in all branches of Petroleum Industry**

NOTHING, neither the charm of New Orleans, the piquancy of the French Quarter, nor the offshore rigs, interrupted the technical sessions of the 15th Annual Petroleum Mechanical Engineering Conference sponsored by the Petroleum Division of The American Society of Mechanical Engineers.

The technical conference, attended by 700 engineers, presented with the cooperation of the ASME New Orleans Section, was held September 19–21 at the Jung Hotel. However, the business of the petroleum industry was thoroughly examined through the eyes of the working committees of the Division starting as early as Saturday, September 17, and continuing through Thursday, September 22.

Technical Program

The bywords at this conference were creativity and economy. In 26 sessions the engineers searched for the kind of creative thinking that results in more efficiency in all departments, through a free exchange of technical advancements, to reduce production, transportation, and refining costs.

There is a cost-cutting wave on in the industry that once treated money like it was going out of style.

The discussions brought to light a concern about petroleum and natural gas costs pricing themselves out of competition with other and better known and cheaply produced fuels.

In order to keep petroleum in the lead as an energy source, not a possibility was overlooked in the program. Authorities covered practically every phase of the industry including improvements in steelmaking to improved methods of combating corrosion, development of new equipment in all branches of the work, and the testing of new materials that have been investigated as capable of possible use industrywise.

In addition, the growth of the petrochemical industry is conceded to be one of the giant steps in the petroleum industry. Rubber made from crude oil is fast becoming commonly known and used in the making of tires for automobiles and trucks as well as aircraft, tractors, and big mobile machinery.

Plastic Pipe. Light, strong, plastic may some day replace steel in almost every type of oil-industry construction and process, F. R. Campbell predicted. Professor Campbell, of the Colorado School of Mines, said that plastics already are being used by the oil industry in piping. And heavy-duty structural pieces may soon be made of the material.

One big advantage of using plastics in piping is its quality of inertness. Unlike metals that tend to react to chemicals and corrode, plastics remain the same.

He said tests are being made on the use of heavy-duty plastic beams and other structural shapes. In some cases, plastics might be reinforced and used.

P. A. Randolph, The Fluor Corporations, Ltd., added that plastic is being tested and used to replace rubber in gaskets and seals. He said the material has a built-in lubricating quality and does not deteriorate. However, both men agreed that steel will always do many jobs much better than any known plastic substitutes.

Industrial Photography. R. J. Tiller, senior engineer, Monsanto Chemical Company, St. Louis, Mo., emphasized the use of photography in formulating engineering plans. Photography is being used to produce engineering plans that contain more information and are more easily understood; yet they require 20 to 60 per cent less design time and cost to prepare than do conventional drawings, he pointed out.

"Photodrawing is another tool that can be used to improve the efficiency and effectiveness of an engineering organization," he said.

Each project should be examined for areas in which photography can improve design communications, Mr. Tiller added.

"Photography will never completely eliminate draftsmen or the use of orthographic drawings," he stated. "It is, however, a powerful engineering tool that will more effectively utilize scarce

"I now present a certificate to..."

J. P. Mooney, chairman, Petroleum Division Executive Committee, with certificates for outstanding service for...

...T. L. White, past-chairman of Petroleum Division Executive Committee. Mrs. White looks on.

F. K. Zerbe's wife smiles approval when her husband, 1959 chairman, Membership Committee, receives certificate

technical manpower and, through more clear communication of design intent, will improve the quality of engineering design and construction."

Scale Models. The use of three-dimensional scale models, D. J. Fries of Foster-Wheeler Corporation pointed out, has introduced a great change in process-plant layout and engineering. They appear to be industry's answer to the effect of the machine age on design drafting practices. Management was given a thorough going over and it was pointed out that the practice of management requires "measures of professional confidence, theory, and application." It is necessary that the supervisor should become well grounded in the fundamental theory of management, then strive to apply these principles. Learning the theory is one thing, applying it to a "personal, emotionalized situation" is something else. Becoming a manager also means becoming a student. The job is "both a classroom and a challenge."

Creativity. The general concepts of creativity and the important attributes of an engineer to be truly creative were discussed by a leader in petroleum research. Later, a panel on encouragement of creativity by company policy summed up that money cannot buy creativity but it can supplement and create a healthy atmosphere for creative thinking, encourage achievement and satisfaction.

Social Events

It would not be factual to say, however, that the conference was all business. The New Orleans Section started the festivities on Sunday evening with a "Get Acquainted" Reception.

Luncheons. Monday, at the Welcoming Luncheon, the Mayor of New Orleans, de Lesseps S. Morrison, greeted the engineers with a color motion-picture film depicting the effect a $4-million improvement program so far had on this 242-year-old city. The Mayor presented Harold Grasse, Vice-President ASME Region VIII, with a key and certificate. T. M. Mixon, chairman, Section-Division Conference Arrangements Committee, made the introduction, and G. J. Groh, chairman of the ASME New Orleans Section, presided. Allen Jensen, the incoming Vice-President, was introduced to the audience of 400.

At noon on Tuesday five Industry Luncheons were held in Drilling and Production; Manufacturers; Materials; Refining, Gas Products, and Petrochemical; and Transportation. These luncheons are a feature of long standing. More questions are asked and answered here than on a quiz show (unrigged, of course) and what is learned goes a long way toward clarifying a testy problem, a method, or knowing what is going on in other "shops."

Banquet. The banquet, preceded by a social hour, is always the capital event of a conference. Engineers recognize outstanding professional contributions of their fellows, but this year there was a lagniappe that was a pleasant surprise. Eugene Jacobson, who did so much to "revive and revitalize" the Petroleum Division, was called on to receive the second check for $1000 from the Division to be added to the ASME Campaign Fund for the new United Engineering Center, presently under construction in New York City.

T. M. Mixon, who presided, called on F. H. Walk, vice-chairman of Section-Division Conference Arrangements Committee, to introduce the principal speaker of the evening, Elmo W. Koschel, general sales manager, Southern Bell Telephone and Telegraph Company, New Orleans, La. Mr. Koschel in his talk, "Man's Fourth Adjustment," warned that "there is no guarantee against obsolescence." Pointing out that the history and geography books we used in school are obsolete —even the American flag which stood so proudly in the corner has changed—he asked: Are you and your industry planning for the future?

The petroleum industry, he added, is convinced that there is no competitive substitute for its major product—gasoline. He then showed how fallacious this thinking is.

"First," Mr. Koschel said, "crude oil was used as a patent medicine; then we had the development of the kerosene lamp; and while the industry was waiting for lamps all over the world to be lit, Edison invented a light which was not dependent on oil. If it had not been for the growing use of kerosene in space heaters, Edison's lamp would have completely finished your industry at that time except perhaps for the by-product, axle grease. While your industry was on the ropes staggering from the blow of the coal-burning domestic central heating system, someone outside of your industry brought on the scene the internal-combustion engine. In the 1920's, as gasoline began to level off, again an outsider came with the central oil heater to boost your sales. As that demand leveled, war demanded aviation fuel, and after the war we saw the expansion of civilian aviation, the dieselization of railroads, and the explosive demand for high-powered cars and trucks."

In closing he said, "If you, in your en-

J. W. Young, reporting representative, Annual Meeting, 1958-1959, accepts certificate

C. W. Lubbock, reporting representative, Summer Annual Meeting, 1960, is thanked for his services

H. L. Norris, Jr., and his wife, stand as he is presented with certificate for his work as chairman of the Manufacturers Committee, 1958-1959

G. E. Nevill, chairman, Materials Committee, 1958-1959, receives award

Earl Seaton is congratulated on his work as chairman of the Publicity Committee, 1958-1959

gineering and research, do not make your products obsolete, someone else will."

Field Trips

Several interesting and informative field trips were available on Thursday, September 22. The Continental Oil Company, Humble Oil & Refining Company, and The California Company conducted tours to their offshore rigs.

Optional sight-seeing tours also were available in New Orleans which included boat trips on the Mississippi River and in the bayou country.

1961 Petroleum Conference

The 16th Annual Petroleum Mechanical Engineering Conference will be held at the Muehlebach Hotel, Kansas City, Mo., September 24–27, 1961. The Petroleum Division's Host will be the ASME Kansas City Section.

Availability List—Petroleum Engineering Conference

THE papers in this list are available in separate copy form until July 1, 1961. Please order only by paper number; otherwise the order will be returned. You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 50 cents each to members; $1.00 to nonmembers. Payment also may be made by free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $4 to members; $8 to nonmembers.

60—PET-1 Are You Considering Numerical Control? by J. A. Baker

60—PET-2 Design Against Excessive Plastic Deformation, by W. P. Kerkhof

60—PET-3 Models—A Basic Tool in Process-Plant Design, by D. J. Fries

60—PET-4 The Mechanical Aspects of Rig Moves, by M. T. Parker

60—PET-5 New Instruments Improve Depth Accuracy, by W. E. Bowers

60—PET-6 Automation for Liquid Pipe Lines, by J. F. Stephenson

60—PET-7 Continuous Corrosion Monitoring With Corrosion Probes, by E. S. Troscinski, A. S. Couper, and A. Dravnieks

60—PET-8 You, Too, Can be a Creative Engineer, by C. R. Hocott

60—PET-9 Graphical Solutions to Some Statistical Distributions, by C. F. Lewis

60—PET-10 Solid Films—Lubricants for Extreme Environments, by C. F. Merrill and R. J. Benzing

60—PET-11 Practical Aspects of the Heat Treatment of the High Speed Steels, by D. C. McKissick

60—PET-12 Cemented-Oxide Cutting Tools Where They Stand Today, by G. A. Morrison

60—PET-13 Aluminum Applications in the Petroleum Industry, by P. E. Brandt and R. W. Flournoy

60—PET-14 Design Application of Engine-Drive Balanced-Opposed Gas Compressor for Pipeline and Process Installations, by W. M. Kauffmann

60—PET-15 An Automatic Control System for a Gas Pipeline Compressor Station, by K. S. Hagius and L. R. Henry

60—PET-16 Some Results on Continuously Drilled Fixed Tube Plates, by G. D. Galletly and D. R. Snow

60—PET-17 Ultrasonic Testing, by C. E. Lautzenheiser

60—PET-18 Thin-Wall Pipe for Oil and Gas Lines, by W. P. Heineman

60—PET-19 Technical Computer Applications in Exploration and Production, by W. S. Pickrell

60—PET-20 Computer Simulation of Marine Terminal and Pipeline Operations of the Trans-Arabian Pipe Line Company, by D. W. Dreier and B. A. Sachs

60—PET-21 Design Data for Pipeline Branch Connections, by T. J. Atterbury and G. M. McClure

60—PET-22 High-Temperature Stability of Tubular Products for Oil-Refinery Use, by A. B. Wilder, D. B. Collyer, E. F. Ketterer, and D. T. Boughner

60—PET-23 Supercompressibility Factors for Gas Pipeline Measurement Automation, by E. Gordon

Well Done. W. M. McCardell, **left**, congratulates R. C. Brooks, chairman of an outstanding drilling production session as A. F. Rhodes looks on. Emile Brinkmann, **right**, served as vice-chairman of the session. Two days later it was announced that the world's largest mobile drilling barge had been named for Mr. Brinkmann who designed it. The barge when completed will measure 186 ft by 264 ft, plus a heliport which will give it an over-all length of 304 ft.

60—PET-24 How Economics Influenced the Design of a 15,000-Psi Blowout Preventer, by R. C. Brooks and G. E. Nevill

60—PET-25 Computer Program to Determine the Throughput Rate of a Heated Pipeline, by D. R. Horner and P. Fried

60—PET-26 Stress Analysis of a Cylindrical Shell-Ring Stiffener . . . Application to Oil Storage Tanks, by I. M. Daniel

60—PET-27 New Developments in Surface and Subsurface Storm Chokes, by P. S. Sizer and W. W. Dollison

60—PET-28 The Design of Semipermanent Gas Compressor Stations, by J. L. Joplin

60 PET-29 Sulfur Recovery From Petroleum Gases, by R. A. Graff

60—PET-30 Use of Copper Alloy Tubes in the Petroleum Industry, by E. J. Duffy

60—PET-31 Maintenance of Turbocharged Engines Including Large and Medium Sized Units in Gas Transmission, Petrochemical and Gas Processing Plants, by J. H. Caldwell

60—PET-32 Utilization of Photography in Plant Engineering, by R. J. Tiller

60—PET-33 Automatic Vapor-Pressure Controller for Optimum Volatile Injection Into Crude Lines, by P. R. Scott

60—PET-34 Rate Your Supervisor—A Program for Supervisory Self-Development, by P. W. Maloney and P. J. Patinka

60—PET-35 Bimetallic Pipe, by D. Christopher

60—PET-36 Recent Developments in Field Gas-Handling Facilities, by W. D. Clift, R. R. Die, and H. R. Galloway

60—PET-37 Photography for Plant Maintenance, by C. B. Hammond

60—PET-38 Evaluation of Glass Reinforced Plastic Pipe, by R. M. Levy

60—PET-39 Economic Development of Prime Movers Using Natural Gas Fuels, by R. F. Moser and R. M. Greene

60—PET-40 Fuels for Argentina, by J. T. Cannan

60—PET-41 The Effects of Internal Pressure on Thin-Shell Pressure Vessel Heads, by E. O. Jones, Jr.

60—PET-42 Modern Developments of Centrifugal Pumps, by C. Bartolero and E. E. Lindros

60—PET-43 Use of Turbine Type Meters for Pipeline Metering, by W. W. Holt, Jr.

60—PET-44 Noise-Abatement Methods in Meter and Regulator Stations, by W. F. Kienast

60—PET-45 General Aspects of Offshore Lease Automation, by W. J. Rapson, Jr.

60—PET-46 The Hydraulic Wall-Anchored Drill Collar, by J. M. Kellner and A. P. Roberts

60—PET-47 Correlation of a New Design Concept for High Horsepower Reciprocating Pumps With Test Results, by F. C. Christ

60—PET-48 Radioactive Measurement of Fluid Density, by D. C. Hartweg

60—PET-49 Pipe Stresses When Drilling From a Floating Vessel, by E. R. Lind

Warren Foresees Steam Production by Hydrogen Bombs

ASME's Technical Development Committee Takes Up "Operation Plowshare," Peaceful Use of Atomic Energy

FUTURE sources of power may be found in harnessing the steam produced by underground explosions of hydrogen bombs. This possibility was cited by Glenn B. Warren, past-president of ASME and a vice-president of General Electric, at a luncheon at Watertown, N. Y., Sept. 16, 1960. Mr. Warren was there to receive the New York State Society of Professional Engineers' "Engineer of the Year" award for 1960.

This plan, in which Mr. Warren sees possibilities, was among ideas discussed by Dr. Edward Teller, "father of the hydrogen bomb," at a meeting of the Technical Development Committee of The American Society of Mechanical Engineers at New York, N. Y., early in September, 1960. This and similar plans for the peaceful use of atomic energy are part of "Operation Plowshare." A discussion of engineering applications for underground nuclear explosions appeared in the January, 1960, issue of MECHANICAL ENGINEERING, p. 36.

Glenn B. Warren, **left,** Past-President of ASME and a vice-president of General Electric Company, is named "Engineer of the Year" by the New York State Society of Professional Engineers. The recognition, in the form of a plaque, was awarded during a luncheon in Watertown, N. Y., Sept. 16, 1960, marking the annual fall meeting of the professional engineers' society. Presenting the plaque is V. E. Hall, PE, of Syracuse, N. Y., president of that society.

Deep in the Ground. The use of the atomic bomb as a power source might work this way, Mr. Warren said:

"We would make a hole in the ground, 10,000 ft or so deep with a large cavern at the bottom, fill it with water, then drop a bomb into it, say every two or three weeks, and harness the steam that results from the heat of the explosion.

"Harnessing of power by this explosion method of fusion might be quicker and easier than with the continuous fusion processes which are now being investigated and which might require containment of extremely high pressures and temperatures."

Energy from such bombs seems to be low in cost, Mr. Warren reported. He quoted Dr. Teller as believing that biologists have exaggerated—perhaps by 10 to 1—the possible detrimental fallout effects of nuclear explosions. Mr. Warren added: "Nuclear explosions underground would be very completely contained."

He added that one of the biggest obstacles now facing Operation Plowshare is the molding of favorable public and political opinion and understanding toward it. There is also the need to offset international barriers to continuous studies of these energy sources.

Mr. Warren listed a number of other possible peaceful uses of atomic explosions which had been discussed at the meeting of the Society's Technical Development Committee. They were:

Creating underground reservoirs for flood waters, and replenishing subsoil water from flood waters which run off.

Open-pit strip mining to depths of 500-700 ft, possibly for oil shales or oil sands.

Moving earth to make artificial harbors.

Distillation of oil shales in place underground.

Underground chemical factories which would change the characteristics of minerals and other materials.

Engineer of the Year. The Engineer-of-the-Year award conferred on Mr. Warren by the New York State Society of Professional Engineers recognizes his pioneering and engineering leadership in steam, gas, and marine turbines and aircraft jet engines.

. . . at ASME-AIEE National Power Conference

Power-Plant Automation and Advancement Featured at Technical Sessions

Two sessions on power-plant automation drew capacity crowds with standing room only at the National Power Conference, held in Philadelphia's Bellevue-Stratford Hotel, September 21–23, 1960. The papers presented dealt with all phases of computer application to automation of plant components—boilers, turbines, and generators—as well as their use for unit-performance calculations. The related problem of remote-burner-systems experience was also considered. Three of the automation papers have been condensed and appear on pages 68–73 of this issue. Well over 900 registered for the three-day conference jointly sponsored by the Power Divisions of The American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

Technical Sessions

Smoothly programmed and extremely well-chaired technical sessions struck a good balance between the awareness of the most advanced technology and a "calm and realistic appraisal of the situation that will obtain in the future," as presented by J. H. Foote, past-president, AIEE, Mem. ASME, and chief engineer of Commonwealth Associates, Inc., in the session on the advancement of power engineering.

Stressing the changes in electric load from the one-flatiron, one-electric-fan, low-wattage-lighting pattern that characterized the household load 40 years ago to the typical modern home with 28 or more electric motors, Mr. Foote stated that electricity has come into the luxury, the convenience category, and the electric company will get a geometrically progressive fraction of the income above the subsistence level. Some of the broader changes that he predicted for the utility industry are described on page 82 of this issue.

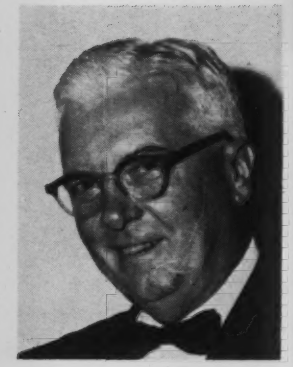
Outlining the shape of things to come, the panel discussion on advancement, included the type of training that the engineer of the future will need. This was presented by E. T. B. Gross of Illinois Institute of Technology. Dr. Gross stated that the growing importance of advanced mathematical and scientific skills may crowd out all attention to hardware in the curriculum. Industry may have to supply that knowledge after a thorough theoretical and research foundation has been supplied. Looking twenty years ahead, rather than the decade favored by many forecasters, the panel concluded that the power plant of 1980 will not be radically different from that of 1960. Allowing for the gradual spread of nuclear power as it becomes competitive in high-cost areas, the bulk of power generation will probably continue to be coal or natural-gas fired with oil decreasing as competitive uses increase. The large reserves of brown coal, lignites, and other lower grade fuels have been scarcely tapped. The fuel cell and thermoelectric devices, magnetohydrodynamic and other plasma systems are unknown quantities. Prospects in the present state of their technology are poor. Efficiencies are ridiculously low in operating devices although in theory they are much better and in the laboratory somewhat improved. Radical innovations in methods or materials may be achieved at any time between now and 1980, however. The best prospect for them seems to be in conjunction with nuclear power.

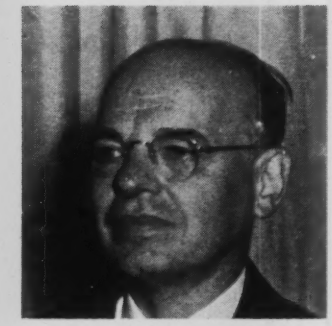
J. J. O'Connor, managing editor, and Norman Peach, associate editor, of McGraw-Hill's *Power* magazine extrapolated a statistical survey of the trends in types of components, auxiliaries, and their combination. Offset copies of the report, which contains numerous bar charts and graphs, are available from them on request.

Stressed in other sessions was the stalemate on materials, particularly as far as costs are concerned, which has halted the trend to higher pressures and temperatures in the search for greater thermal efficiency. This was not only emphasized by P. H. Knowlton, Jr.,

National Power Conference Banquet Head Table

Left to right:
E. B. Shew
E. C. Gaston
Dean D. E. Marlowe
J. H. Kinghorn
Wayne C. Astley
R. L. Halberstadt





Honors and Awards. The ASME George Westinghouse Award was conferred on E. C. Gaston, **top photo,** for "distinguished leadership in generating-station design and operation." J. H. Harlow, **center photo,** and S. N. Fiala, **bottom photo,** received the Prime Movers Committee Award for their separate papers on two supercritical-pressure power plants.

Fellow ASME, advance design engineer, Large Steam Turbine-Generator Department of the General Electric Company, whose paper is condensed on pages 58–63 of this issue, but by R. A. Baker, Mem. ASME, chief engineer, Public Service Electric and Gas Company. Mr. Baker stated that design conditions for the newest Public Service unit have been reduced to 1000 F because "the cost of austenitic steel has increased so much faster" than other costs that it is impossible at this time to "economically justify unit designs which require this material" except perhaps in piping. Turbine exhaust losses were examined in another paper for the way in which they could be reduced to contribute to thermal efficiency.

The need for increased reliability in power service was stressed in several papers. The complexity of restarting integrated automatic processes in the chemical industry places a premium on even 30-cycle disturbances which can bring about as costly a shutdown as longer outages. Other industries will experience the same difficulties as the time comes when processes which do not come to a uniform halt are linked together more closely. The particular problems of an integrated steel plant were also presented. An author from Gulf States Utilities told how important the provision of quality service, with capacity additions anticipated well in advance of demand, had been in bringing new chemical plants to the Texas Gulf Coast.

The problem of co-ordination of generation and transmission and operation was introduced with a study of integrated planning for the five-state Rocky Mountain area where three isolated systems are being tied together to take advantage of different seasonal peaks. The Pacific Northwest and Southwest power pools will also be linked as a result. The area is particularly favored with vast reserves of low-grade coals that will be used in a midway Four Corners power plant located close to the fuel rather than the heavy-load centers. An Eastern example of similar problems is the General Public Utilities System which operates in areas scattered through Pennsylvania and New Jersey. Current tends to flow from west to east because of cheaper generation in the fuel-rich Pittsburgh area. The system is tied into the Pennsylvania-New Jersey-Maryland interconnection at 11 points, and together with the other companies in that interconnection provides a 14-million-kw power-exchange pool, the largest in the country operating on a fully integrated economy basis. The system also has five interconnections to upstate New York utilities.

Comparisons of the input-output and heat-loss methods of code testing of large boilers, and a study of proper methods of starting and loading boiler-turbine-generator combinations to provide thermal-stress protection rounded out the technical sessions.

Luncheon and Banquet

"If Carnot Were Here" was the topic of ASME President Walker L. Cisler's luncheon address. He stated that all of the signs in this age of astonishing progress in technology, in which engineers have key assignments, point to increasing demands for mechanical and electrical engineers. In retrospect, the concept of the reversible heat cycle, and the efficiency formula $e = \frac{T_1 - T_2}{T_1}$ which Carnot developed in his "Reflections on the Motive Power of Heat" in 1824 were to have as profound and widespread effects as Einstein's $E = mc^2$ is having today.

In a world in which "slides on the sledges"—something like our roller coaster—and a two-wheeled bicycle pushed with the feet were among the favorite mechanical forms of amusement, Sadi Carnot was able to develop the "abstraction of all heat engines that have been invented and will be invented." In a Paris in which steamboats had just appeared on the Seine, and 300,000 horses—almost half as many as there were people—provided the motive

Head Table (cont.)
T. S. Fetter, Jr.
C. A. Woodrow
C. B. Campbell
Howard H. Sheppard
J. H. Foote
Rev. Carl S. Winters

power on unpaved streets, Carnot pointed out that "nature in providing us with combustibles on all sides has given us the power to produce heat at all times and all places."

In the latter part of the same century it could be said that "iron and heat are the basis of the mechanic arts . . ." and the destruction of Britain's Navy would have been less serious than taking away her steam engines.

Carnot did not have the advantage of the molecular theory of heat and did not realize that some of the heat was transformed directly into energy. "Picture his amazement at a nuclear reactor the size of a rain barrel that can produce 300,000 kw of energy."

Speaking of the spirit of mutual interest and mutual opportunity for new endeavor that exists in a world grown close together, Mr. Cisler used Carnot's formula as an analog for producing a more efficient world in which a few fortunate countries are designated as the T_1 nations and in which many are T_2. The T_2 nations cannot develop wholly on their own initiative, he stated, the more favored nations will have to help them to become more effective.

The Prime Movers Committee Award was presented at the luncheon to James H. Harlow, Fellow ASME, chief mechanical engineer of the Philadelphia Electric Company, for his paper "Engineering the Eddystone Plant for 5000-Lb 1200-Deg Steam;" and to Sigmund N. Fiala, Fellow ASME, vice-president of American Electric Power Service Corporation for his paper "First Commercial Supercritical-Pressure Steam-Electric Generating Unit for Philo Plant."

T. S. Fetter, Jr., Mem. ASME, staff engineer of the Philadelphia Electric Company, and chairman of the Philadelphia Section of The American Society of Mechanical Engineers, was toastmaster at the luncheon.

It was something new to have a Baptist minister, Rev. Carl S. Winters, deliver the banquet address. It was even more unusual to have him representing the General Motors Corporation. After 20 years as pastor of the First Baptist Church in Oak Park, Ill., and nine years as pastor at Jackson, Mich., Dr. Winters entered a contract with General Motors in September, 1959. The only prohibition was that he could not speak about General Motors products. He is permitted to devote full time to writing, lecturing, and travel. He has also been chairman for the past five years of Chicago's Skidrow Commission and a member of the board of the John Howard Commission. Both organizations are concerned with crime prevention and the rehabilitation of released prisoners.

Dr. Winters gave a serious address on "The Fine Art of Living" which won him a standing ovation. His address was generously relieved with such jokes as "life is one fool thing after another, love is two fool things after each other." He cautioned against being the man "who has his religion in his wife's name." Stating that "service is the rent you pay for the space you occupy on earth," he described the art of serving as one of the greatest lessons in learning the art of living.

In America, Dr. Winters said, we make a pattern of togetherness—defined as the difference between going it together and going it alone.

He concluded by stating that there are a million unfinished tasks in our underdeveloped world which greatly needs engineers. "You are on the launching pad—get into orbit, and don't be fooled by the nincompoops."

The ASME George Westinghouse Gold Medal was awarded to Ernest Charles Gaston, Mem. ASME, engineer, Southern Services, Inc., for "distinguished leadership in generating-station design and operation in the development of a major power system."

E. B. Shew, chairman of the General Arrangements Committee for the Power Conference was banquet toastmaster.

Inspection Trips

The Switchgear Factory and Laboratory of the General Electric Company, the Turbine and Heat-Transfer Facilities of the Westinghouse Electric Corporation, and the Eddystone Station of the Philadelphia Electric Company were visited on the inspection trips. The Unit No. 1 of the 5000-psig 1200-F Eddystone Plant is operating at 1150 F until its first dismantling. This June it achieved its 325-mw name plate rating, and it has been in continuous service since July 5. The unit is practically base-loaded and Unit No. 2, of identical rating, is now being installed. The many unique features of this supercritical-pressure plant have been presented at ASME Meetings and in previous issues of MECHANICAL ENGINEERING.

Availability List—ASME-AIEE Power Conference

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60—Pwr-1 Automation . . . The Application of Computers to Automatic Boiler Operation, by G. W. Kessler

60—Pwr-2 Industry's Need for Quality Electric Power Service, by R. W. Worley

60—Pwr-3 Thermal Stress Protection in Starting and Loading Boiler-Turbine-Generator Combinations, by R. H. Reisinger and C. B. Sharp

60—Pwr-4 A Look at Big-Power Cycles for 40 Per Cent Thermal Efficiency or Better, by P. H. Knowlton, Jr.

60—Pwr-5 Code Testing of Large Boilers-Input-Output or Heat-Loss Method? by J. A. Bostic and W. F. Long

60—Pwr-6 Eight Years' Experience With Automatic Burner Controls, by R. Forney

60—Pwr-7 Turbine-Exhaust Losses, by C. E. Seglem and R. O. Brown

Conducted for the National Junior Committee

J.W. FOLLANSBEE[1]

JUNIOR FORUM

ASEE and Industry Explore Areas of Responsibility

EACH year the American Society for Engineering Education has a college-industry conference. Here are summations of the major addresses given at this year's conference, held on Washington University's campus in St. Louis, Mo. The main theme was the responsibilities of industry, universities, professional societies, and the graduate engineer toward one another.

Responsibilities of Universities to Young Engineers in Industry. E. F. Branahl of McDonnell Aircraft Corporation, St. Louis, who works in the field of space technology and missiles, considered the needs of the young engineering graduate engineer just beginning his career in the aerospace industry. In general, such a man will find himself in one of two situations. Either he will work in a technical group charged with arriving at detailed answers to specific questions, or he will become part of a design team aimed at putting together an over-all design.

In the first case, most of the people in his department will be highly trained in a special field. He will realize he has not received this depth of training as an undergraduate, and will desire to go to graduate school. In the second situation, the man will find his undergraduate training too narrow, and will find he needs more training in many fields, but not to so great a depth.

So here are two general categories of people who feel they need training, who need it now, who would like to go to universities, and who need a schedule that fits their work schedule and required course content.

These are immediate needs. If the man were foresighted enough, he would also recognize that he should take courses now that will apply in the future. This background leads to five responsibilities of universities to both student and graduate engineers:

1 Undergraduate courses should place more emphasis on fundamentals than they have in the past.

2 Universities have a responsibility to keep their curriculums in the graduate school current.

3 Universities must continue their characteristic basic research; but in addition should inject into their current courses subject matter which, in their best judgment, will be of value 10 or 15 years hence.

4 The quality of teaching in the graduate school should be continually improved.

5 Graduate courses should be offered at a time that will not conflict with the graduate engineer's job. Universities and industry should co-operate to arrive at a time that is acceptable to both.

Mr. Branahl elaborated on three of his points. He suggested that professors accept summer employment in industry to get military clearances required to find out what's new in military fields. As to study for future needs, the engineer won't have time to pick up courses 10 or 15 years from now: Hence the wisdom of taking "way-out" courses when he can. As to point four, Mr. Branahl dwelt on the ability to teach rather than on technical qualifications.

Responsibilities of the Graduate. Richard Dammkoehler of IBM Corporation asked what the engineer must do to insure his continued education and advancement.

The answer, he said, is relatively simple. The man's growth and development will be a direct result of how well he can organize and use his talents. His own efforts will make him professional. To achieve professional rank, he must go in for additional study, extracurricular activities, reading his professional journals, and contributing his own work to the profession. Although this new engineer often cannot help his university financially, he can feed back information.

Responsibilities of Industry to the Engineering Graduate. W. R. Persons of Emerson Electric Company had surveyed publications on this subject, finding the usual points to be these: Providing adequate policies; initiating adequate controls; planning proper organization; informing of company objectives; evaluating results.

These are important objectives, but what is actually happening? In a recent survey made by Booz, Allen, and Hamilton, they found that approximately half the engineering and research personnel in industry were not aware of the company objectives; that 40 per cent knew of no adequate policy formulation within their companies; that top-management control of research and development was unsatisfactory 64 per cent of the time.

We in industry must break down some of our own fallacies, Mr. Persons said. For example, "Scientists and engineers work more effectively when given greater freedom." Evidence shows that scientists and engineers want more effective direction and supervision. They regard the lack of effective supervision as the second most critical problem in the laboratory.

"R and D should select the projects on which it works." Actually, project selection is an integrated, total company effort, with every major area of the enterprise represented. This cuts project failure, keys research to desired objectives, and improves R-and-D effectiveness.

"R-and-D effectiveness has been seriously limited by a lack of creativity."

REMINDER

Last month we previewed the Junior session of the 1960 ASME Winter Annual Meeting. As a reminder it will be held at the Statler Hilton Hotel in New York on Wednesday, November 30, at 8:00 p.m.

The theme will be "Professional Aid for the Young Engineer." Topics will include one talk on the session theme, others on "How Participation in Professional Activities Can Aid the Young Engineer," "Benefits I Derived From ASME," and one talk about Old Guard activities in connection with the young engineer. The NJC chairman will round out the session with a brief talk. After the scheduled talks the floor will be opened to the audience. For more details, read our notice in the October Junior Forum.

[1] Designer, Voorhees, Walker, Smith, Smith & Haines, New York, N. Y. Assoc. Mem. ASME.

Today, in the major labs, creativity is like money; everybody would like more, but enough is present for a comfortable standard of living.

"Training and development in R and D is best accomplished by professional meetings, writings, speeches, and additional formal education." These factors help, but the key to effective development is strongly accented on-the-job training.

"Compensation is a major problem in R and D." Some problems do exist, but both management and the men in the laboratories rank compensation in eighth place among problems of consequence.

Nominations Open for 1962 ASME Officers

Section Advisers to Regional Advisory Committees on Nominations Provide Channel for Suggestions Requested From Each Member

ALTHOUGH you have just recently had the opportunity to vote for and elect new National and Regional officers who will be responsible for the direction of the Society beginning in 1961, it is already time to start planning for the selection of officers for 1962. This never-ending search for the best qualified members available to serve in the administration of ASME is but the exemplification of our principle: The office shall seek the man. Nominations are now open for those offices listed below and by the democratic process of the Society's procedure, you as a member are obliged to initiate such action.

In contrast to our country's national elections, which we have just experienced, the National Nominating Committee is charged with selecting a single slate of candidates for whom you will have an opportunity to vote next September. In order to choose the best possible candidates, the Committee must have the nomination proposals of the best qualified members who are available to serve—and these nomination proposals must come from you, the regular members of the Society.

Thus it is impossible for the Nominating Committee to function as it should without your help. You, as individual members in each of our 98 sections—you know who the local members are that really make ASME "tick." You can recognize who should be the future Regional and National officers. But the National Nominating Committee may never learn of these outstanding men unless you act in their behalf.

To assist you, a direct line of communication has been established between your individual section and the National Nominating Committee. Each section has been asked to appoint a member as an adviser on nominations. Within your region, the chairman of the Regional Advisory Committee on Nominations will serve as chairman for this group of advisers. He is an individual with nominating committee experience. You can obtain the name of the adviser in your section by asking your section chairman. The names and addresses of all the members and alternates of the 1961 National Nominating Committee were published in the August, 1960, issue of MECHANICAL ENGINEERING, page 127.

If you know men in your section who have the acknowledged qualities of outstanding ability and leadership in their profession, please suggest them to your section adviser on nominations or, better yet, act as a sponsor for such men. Your nomination sponsorship must be on a form, which you can secure from headquarters in New York or from your regional member of the National Nominating Committee.

Those of you who are active in the Professional Divisions as well as those in section activities should particularly be able to give sound recommendations to your section adviser on nominations. While the Boards, Committees, and Professional Divisions make recommendations through nominating conferences provided for in the Constitution and By-Laws of the Society, your suggestions to them can also be invaluable. Accordingly, you may make your nomination through your group's representative or directly to James R. Muenger, Secretary, 1961 Nominating Committee, ASME, Texaco, Inc., Beacon, N. Y.

Offices to be filled for 1962

President	To serve 1 Year
Vice-President Region I	To serve 2 Years
Vice-President, Region III	To serve 2 Years
Vice-President, Region V	To serve 2 Years
Vice-President, Region VII	To serve 2 Years
Vice-President, Region IX	To serve 2 Years
Three Directors (at large)	Each to serve 4 Years

It is your obligation, privilege, and responsibility as well as that of every other member of the Society to assist the National Nominating Committee in obtaining the best men available for officers of The American Society of Mechanical Engineers.

Plan Ahead

A SYMPOSIUM on the Dynamic Characteristics of Heat Exchangers is being planned for the 1961 ASME Winter Annual Meeting, New York City, during the first week of December, by the Heat Transfer Division Committee on Unfired Heat Transfer Equipment. This activity is being designed in accord with the continually increasing importance of dynamic response characteristics in the design and analysis of thermal systems involving heat exchangers.

Suitable papers now are being solicited for the symposium, subject to review and acceptance by the Papers Committee of the Division. All aspects of dynamic response are to be considered, including thermal effects coupled with other phenomena.

Papers to be submitted should be in accord with the following schedule:

1 Notification of intent is desired no later than Feb. 1, 1961.

2 Four (4) review copies of the paper, in accord with ASME standards, are needed no later than May 1, 1961.

All correspondence and manuscripts are to be addressed to the Chairman of the Symposium Arrangements Committee, Herbert B. Nottage, 16597 Bosque Drive, Encino, Calif.

Copies of the Manual MS-4, "An ASME Paper," may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price to nonmembers, 50 cents; to ASME members, free.

Management (*Continued from page 124*)

on personal recommendation—the less the hostility.

At the last session, H. W. Johnson, vice-president of planning and research of Inland Steel, reported on education and development of engineers as managers at his company. For raw material, they want educated engineering graduates from the schools. The company will turn them into administrators.

K. B. McEachron, Jr., Mem. ASME and dean of Instruction, Case Institute, spoke on the increasing importance of the management function, and the responsibility of education in producing management material. Charles L. Tutt, Jr., Mem. ASME and administrative chairman for thesis and graduate study programs at General Motors Institute, discussed their student development program.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members or non-members, and is run on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 60 per cent of the first month's salary if a nonmember, or 50 per cent if a member. Also, that you will agree to sign our placement-fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

NEW YORK
8 West 40 St.

CHICAGO
29 East Madison St.

SAN FRANCISCO
57 Post St.

Men Available[1]

Chicago Office

Plant Engineer, BSME, 38; experienced in management, men, materials, equipment, sales, and maintenance. Plant manager, industrial values rebuilder, with full responsibility for all phases of operation, plant, sales, and office; ten years petroleum refinery, head technical maintenance department, management-training program. $12,000. Prefers Midwest. Me-1192-Chicago.

Plant Manager or Plant Engineer, BSME, 37; well-rounded experience, good background in planning, organizing, and directing plant-engineering activities. Thoroughly familiar with all phases of building construction, machine design, plant layout, and maintenance. Competent in personnel supervision. $12,000. Location optional. Me-1193-Chicago.

Management, Chief Engineer, MSME, EE, 38; extensive experience as project manager, chief engineer, electrical utility planning, design, construction, operation. Commercial, technical negotiations, and contract writing. Several years Latin America, Europe. Speaks Spanish, German, Scandinavian. Location immaterial. Me-1194-Chicago.

Executive, Anglo-American, for consultancy, procurement, sales services any location. Presently Midwest. University (England); Chartered Mechanical Engineer, U. S. A.-U.K., widely experienced materials handling and processing (mechanical, pneumatic, hydraulic techniques). Especially interested design, development, marketing new product demanding highest personal management qualities. Me-1195-Chicago.

Sales and Application Engineer, BSME, Univ. of Illinois, 39; sales and consulting engineer for firm fabricating special weldments, mechanical expansion joints, and surge suppressors. Can deal effectively with shop personnel. Broad, diversified knowledge of technical items gained through ten years' experience as assistant plant engineer. $10,000-$11,500. Prefers Chicago Headquarters. Me-2008-Chicago.

Engineering Management, BSME, Magna Cum Laude, 35; 12 years' experience in fields of engineering management, technical sales, and product development. Desires new non-defense challenge. Salary negotiable. Prefers South or West. Me-2009-Chicago.

New York Office

Engineering Supervisor or Manager, BSME; ten years' experience including research, development, production engineering on aircraft and missile propulsion, and control systems. Supervisory engineer and project management. $14,000. Location immaterial. Me-876.

Director of R&D, BSME, MS in mechanics, PhD, except for thesis; experienced as director of marine technology, associate director research and development, project engineer, structural designer, for a total of ten years. $18,000. Location immaterial. Me-877.

Machine-Development Engineer, BSCE; mechanical experience includes 18 years in petroleum research, polymer transport, high temperature, pressure vessels, controls, mechanisms, remote operation, vacuum-melting furnaces, radiant heat, plant contact, consulting. Registered in Pa. $11,500, minimum. East. Me-878.

Mechanical Engineer, BE; 33; eight years' experience which includes mechanical design of hoists, trolleys, and cranes (four years), design of hydraulic presses (one year), and production design for the mechanical installation of components in aircraft (three years). Middle Atlantic States. Me-879

Mechanical Engineer, MSc; 15 years' project and plant engineering experience in expansion and development of industrial plants: layout, process, and pipelines, material-handling machines, maintenance and safety program, coordination and supervision of design and construction, specification, installation, administration, contraction and vendor connection. $9000-$12,000. New York Metropolitan area. Me-880.

Mechanical Engineer, ME; experienced in the design and development of heavy industrial facilities and power plants, start-ups, training of personnel. Fluent Spanish, also speaks Portuguese. $9500 a year. Prefers New York, with some travel as required. Me-881.

Manager, Manufacturing Engineer, Industrial Engineer, or Staff Assistant to Vice-President of Manufacturing, BSME, master's degree in management engineering; 20 years' experience in manufacturing encompassing commercial and governmental programs. Knowledge of production and development. Understands finance, cost accounting, proposal estimating; able to organize to meet schedules and costs; proved ability in business administration. $14,000. New York Metropolitan area. Me-882.

Chief Industrial Engineer, BSIE; handle complete responsibility for methods improvement program; consulting experience; MTM instructing. Presently responsible for a major cost-reduction application involving use of standard data. $15,000. Location immaterial. Me-883.

San Francisco Office

Field, Office Engineer, ME, 26; one-year experience design, schedule, liaison; cost estimating, material scheduling; oil refinery. Two years charge of laboratory for manufacturer of oil tools. Also experienced machinist. Military completed. $7200. Prefers San Francisco Bay area, West Coast. Home: Calif. Se-1739.

Plant Engineer, ME, 32; eight years' experience cost control, reduction, labor standards, plant layout, materials-handling equipment, design of new facilities for food plant and general machinery manufacturer. $7800. Prefer, San Francisco Bay area. Home: Peninsula. Se-1735.

Plant, Sales Engineer; 15 years of varied plant engineering experience at progressively higher levels in petroleum refining, chemical, and utility plants. Seeking position in project or plant engineering, maintenance, operations or sales. $11,000. Any location. Home: Ariz. Se-1699.

Production Supervisor, ME, 28; five years' preliminary cost, budget, and layout preparation for proposed plants, equipment specifications, design and field liaison for oil-producing company. One year time-and-motion study, production control, foundry, test laboratory, machine design, and heat-treatment for farm-machinery manufacturer. Also experienced machinist. Part-time experience as lab assistant on heat and ventilating equipment. $7200. Northern or Central Calif. Home: San Francisco. Se-1815.

Safety, Field Engineer, ME, 41; seven years' experience fire prevention, periodic loss prevention inspections, special studies of industrial fire problems, preparation of loss reports. Review and inspection of fire protective equipment. $9000-12,000. Any location. Home: Ohio. Se-556.

Plant Engineer, Maintenance, ME, 35; seven years' experience superintendent of maintenance, organization, direction, scheduling, recommending purchase of material, budgets, cost control for industrial chemicals company. $12,000. Prefers San Francisco Bay area, Northern Calif. Home: Calif. Se-979.

Instructor, MinE, MetE, 59; Regis ME Penn, 34 years' experience in calculation and laboratory verification of complex structure stresses using most modern techniques; desires instructorship in strength of materials laboratory in engineering school with consulting privilege. Salary open. Pacific Coast. Home: Mo. Se-980.

Junior Mechanical Engineer, CE, 24; recent graduate interested in any type of business or activity, except intimately connected with electricity. Prefers field of hydraulics. $6000.

Additional listings of positions and men available are maintained in the offices of E.S.P.S. Direct inquiries to nearest office. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance.

[1] All men listed hold some form of ASME membership.

Insurance Program For ASME Members Offers Increased Benefits

THE Group Disability Insurance Program which ASME approved for its members started its third policy year on June 1, 1960.

The claim experience of the Program has been sufficiently satisfactory to enable the American Casualty Company to agree to increase the benefits of the Program without any increase in the premium. These additional benefits are as follows:

Under the Loss of Time Plan. All benefits relating to weekly indemnity will be increased 10 per cent for illnesses commencing or accidents occurring on or after Sept. 1, 1960. Thus, if an insured is covered for $100 weekly indemnity, he will now receive $110 per week.

Under the Major Hospital-Nurse-Surgical Expense Plan. (*a*) New coverage has been added providing reimbursement up to $50 for out-patient expenses incurred for treatment or service rendered by a doctor or hospital as the result of an accident, if such treatment or service is received within 24 hours of the time of the accident and is not otherwise covered under the policy.

(*b*) New coverage has been added providing up to $20 for ambulance service, other than an ambulance owned by the hospital. (Hospital ambulance service is already covered under the miscellaneous hospital expense provisions.)

These benefits will be available not only to new applicants, but also to presently insured members who are unfortunate enough to have disabilities occurring after Sept. 1, 1960

Prefers Calif. Home: San Francisco. Se-1840.

Management, Development, Industrial Engineer, ME, 50; experienced management and industrial consultant to industry, municipalities, governments on economic development problems, industrial safety. $10,000. Any location. Home: South. Se-1157.

Design, Research Engineer, ME, 28; one year design, layout new parts, modifications, heavy earthmoving equipment. One year teaching dynamics, test-materials lab, heat-power lab. $6300. Prefers West. Home: Kan. Se-1196.

Research, Development Engineer, MSME, 32; background in heat transfer, fluid mechanics, and instrumentations; experience includes industrial R&D, high-speed aerodynamics research facility and consulting. $900. Prefers San Francisco Bay area. Home: Calif. Se-1201.

Development, Supervision or Sales Engineer, ME, 53; years in top engineering activities—design, development, and sales-process equipment and plans in U. S. and foreign fields. Speaks four languages. $9500. Prefers San Francisco Bay area. Home: N. Y. Se-1308.

Design, Construction Engineer, ME, 36; over eight years' experience on design and construction of chemical plants—piping, heat transfer, etc. $9600. Any location. Home: San Francisco. Se-1315.

Plant Engineer, Designer, IE (mechanical option), 39; heavy plant and design experience in aircraft, automotive, packaging machinery, and power-plant industries. Desires position with small company where growth is prime factor. $7800. Prefers San Francisco Bay area. Home: Calif. Se-1356.

Sales Engineer, ME, 32; solid academic training, some sales experience, four years' manufacturing experience as refinery designs engineer in plant maintenance, revision, and expansion; design, draft, or installation and modification of equipment, machines and plant services. $7200. Prefers San Francisco Bay area. Home: Calif. Se-1366.

Machine, Tool Designer, ME, 31; one-year's experience mechanical design, prototype and supervision of installation of electronic equipment into vehicles for systems research laboratory. Four years tool and die apprenticeship. Working knowledge of job shops. $7440-$8040. Prefers Calif. Home: Calif. Se-1422.

Management, Research Engineer, ME, 36; seven years' experience management in sales, development, field consultation for management consultant. Four years' analysis of plant and service, selection and specifications of equipment, prepare layouts, estimate for budget, economic balances for manufacturer. Two years special studies on internal-combustion engine development. $14,000-$15,000. Any location. Home: Ill. Se-1522.

Sales Engineer, Co-ordinator, Me, 35; four years' experience writing job requests, co-ordinate, design, contract award, inspection, job completion for ballistic missiles; supervise inspection, design on air base facilities, research and development automatic controls and instrumentation for aircraft. Four years' sales of automatic controls and industrial recording, indicating and controlling instruments. $8400. Prefer Rocky Mountains, Foreign. Home: West. Se-1661.

Positions Available

Chicago Office

Production-Controls Supervisor, industrial-engineering degree or management, to 45; administer, supervise, and direct the complete production-control department of an appliances manufacturer. Will be responsible for all planning, scheduling, machine loading, inventory-control functions for a manufacturer of stoves. $10,000–$12,000. Company pays fee. Chicago, Ill. C-8331.

Staff Industrial Engineer, Foundries, graduate industrial or mechanical, with at least five years' experience in gray iron or malleable iron foundry setting standards, methods, time studies, etc. Will be assigned to client's plant in Argentina, S. A., for at least two years then back to Chicago on staff. Will consider married man without children of school age. $10,000–$15,000, depending upon experience, plus a per diem allowance the first three months of employment; round-trip transportation for man and family. Company pays fee. C-8329.

R&D Engineer, BSME, 30–45; at least five years' experience as research or design and development engineer on mechanical, pneumatic, or hydraulic-flow controls or instruments, including valves, pneumatic switches and motors, thermostats, servomechanisms, meters, recording devices, or small mechanisms. Must be imaginative with history of accomplishments including patents, publications, or articles, or original products. High mechanical aptitude, knowledge of manufacturing problems and methods. $8400–$10,000. Company pays fee. North Shore Chicago suburb. C-8327.

Chief Engineer, graduate mechanical, electrical, or metallurgical, 35–50; to work with and direct a small engineering and drafting staff for manufacturer of material-handling equipment. Must have experience in new and special product design or material-handling equipment; in manufacturing engineering in both wood and metal production including light metals, in application of electronic devices to essentially mechanical products, and in purchasing. Must be accustomed to working with top management, as well as sales, production, developing new products, and in simplifying processes and reducing costs on old products for a manufacturer of floor trucks, wheels, and casters. $10,000–$15,000. Company may pay fee. Minn. C-8278.

Product R&D Engineer, graduate mechanical, industrial, or architectural, several years' experience in product design. Should be able to contribute creative ideas in the development of windows, doors, hardware, and allied building products and be willing to assume responsibility in the design department. Good possibility for right man to assume management of product development for a manufacturer. $10,000, plus, depending on experience. Iowa. C-8275.

Project Engineer, to 50; minimum of one to two years technical college. Will be responsible for concept and design of new developments and the follow-through into production design of new product in packaging machinery, working under direction of engineering department. $10,000–$12,000 a year. Company will negotiate fee. Chicago. C-8273.

District Manager, graduate mechanical or chemical, to 45; to contact industrials, steel plants, utilities, consultants in Chicago area selling water-conditioning equipment. Must have Chicago contacts. $10,000, plus, depending upon experience; car furnished. Chicago. C-8249.

Technical Assistant to Vice-President, graduate mechanical, to 35; at least five years' experience in general design and development work. Will act as technical assistant to vice-president in charge of solving mechanical problems on paper coatings and on paper-converting equipment. Must be able to take project, follow-through design and development up to production. Knowledge of drying problems desirable; for a manufacturer of graphic arts equipment. $9000. Company will negotiate fee. Chicago. C-8236.

Engineers. (*a*) Administrative engineer, graduate mechanical or electrical, 35–50; to report to vice-president of engineering responsible for establishing, co-ordinating, and supervising administrative standards on world-wide basis. $12,000–$15,000. (*b*) Executive engineer, mechanical, as mentioned, to co-ordinate technical operations of company. Will report to vice-president of engineering. $15,000–$20,000 a year. Company will pay fee. Company manufactures diesel engines and tractors. Mich. headquarters. C-8315.

Associate Professor of Industrial Engineering, MS degree required, PhD and/or PE desirable; 40–55. Major interest and experience in production and operations research. Opportunity to succeed present department chairman in 1962 and to develop consulting practice. Prefer engineer with considerable industrial experience who would like to enter teaching as a career. Research program that insures employment for 12 months. Salary open. North Dakota. C-7965.

New York Office

Director, Overseas Liaison Service, for the development and sale of special services to management societies and others abroad; receive foreign visitors and provide appropriate services; provide information and other liaison service between management centers abroad, domestic operations, and members. Spanish, German, or French highly desirable. One to two years' overseas business experience desirable. $8000–$8800. New York City. W-9678.

Director for an individual manager guided study program, mature, with a wide knowledge of management subject material and availability of sources of information. Will work with individuals mapping out schedules, checking final theses, etc. $14,000. New York City. W-9677.

Purchasing-Program Director, degree in engineering or industrial administration preferred, at least eight to ten years' practical experience in purchasing management. Some teaching experience helpful. Will plan and conduct seminar programs. $13,000–$14,000 a year. New York City. W-9676.

Manufacturing Program Director, degree in industrial, mechanical engineering, or industrial administration, at least eight to ten years' experience in manufacturing management. Some teaching experience helpful. Must be qualified to create seminar programs and also to conduct these programs. To $10,000. New York City. W-9674.

Manufacturing Engineers, graduate electrical or mechanical, for manufacturing department, operations division, five years' experience in analyzing producibility and solving fabrication and assembly problems of military electronic and electromechanical equipment; familiarity with prototype and production manufacture tech-

niques. Heavy estimating on bid proposals, i.e., machine, sheetmetal, mechanical and electrical assembly. $8000–$10,000 a year. Company pays fee. New York suburban area. W-9657(*a*).

Engineers. (*a*) Plant managers, graduate engineers, for management of small sheetmetal-fabricating plants. To $15,000. Ohio and upstate N. Y. (*b*) Industrial Engineers, graduate mechanical or industrial, for manufacturing plants in sheetmetal fabrication. Juniors, $6800; Intermediate, $8000. N. Y. W-9645.

Materials-Handling Engineer, mechanical or industrial graduate, at least five years' experience in process-manufacturing industries from bulk raw materials to warehousing of finished packaged products. $8000–$10,000 a year. Ill. W-9644.

Mechanical Design Engineer, BS or advanced degree in mechanical engineering, ten to 12 years' experience in design and selection of power-plant equipment and controls. At least four years in responsible charge of such selection for a reactor power plant. Work includes selection of power-plant cycles to match reactor design for specific functions. To $13,800. East. W-9639.

Development Engineer, graduate, considerable experience in the refractory industry, to assist chemical-manufacturing company in the development of ramming mixes for the steel and other using industries. Open. Mich. W-9636.

Mechanical Engineer, graduate, preferably experienced as chief estimator for a large mechanical contractor on heating, ventilating, and air conditioning, for office buildings, laboratories, hospitals, and factories. Will head up mechanical department. Must know mechanical design. $12,000. Conn. W-9631.

Design Engineer, mechanical degree desirable, ten to 15 years' experience, which should include general drafting, design of tools and dies, and automatic machinery. Duties will include design of automatic machinery, small parts feeders, conveyers, orientation devices, etc. Open. Northern N. J. W-9608.

Mechanical Engineers experienced in the design and layout of heavy-duty motor-driven reciprocating compressors and angle gas-engine driven compressors. Upstate N. Y. W-9603.

Plant Engineer, graduate mechanical or industrial engineer, for the direction and supervision of the utilities engineering and maintenance functions in plants, installing and maintaining plant utilities, building grounds and facilities, minimum of five years' experience. From $9600. Western Pa. W-9601.

Chief Engineer, BSME or EE, ten years' supervisory and project-type experience in electromechanical (instrument) field involving design and production. Basic knowledge of physics, mechanics, dynamics, electrical circuits, and servo theory. Must be skilled in good management and personal practices. Company designs, develops, and manufactures high-quality precision electromechanical devices for the commercial and aviation industry. $16,000–$18,000, plus excellent benefits. New York City. W-9592.

Teaching Personnel for Department of Mechanical Engineering, MS or PhD required. (*a*) Assistant or associate professor to teach thermodynamics and fluid mechanics. (*b*) Assistant or associate professor to teach machine design and metallurgy. Salaries dependent upon qualifications. Location, Midwest. W-9582.

Applications Development Engineer, with some experience in sales engineering and/or foundry, metalworking, and electronic techniques. Will be responsible for market segments dealing with metalworking, metal casting, parting, and, perhaps, electronic uses of company's products. Will handle customer end of new product and use development. Handle correspondence and carry out laboratory work when necessary. Travel approximately 30 per cent Mich. W-9574.

Product Development Engineer, graduate mechanical, background in original design and creative engineering. Should be imaginative, highly communicative, with the inquiring mind. Must be able to design and develop new products for manufacture of die case, metal stamping, and aluminum automotive accessory parts. Upstate N. Y. W-9569.

San Francisco Office

Assistant Superintendent, ME or CE, young, single preferred, some working experience after college and aptitude to work with men in field office for a mechanical construction, prime contractor, or large subcontractor; machinery, equipment, and mechanical installations. Will be concerned with assisting superintendent on work progress materials and equipment, time, some estimates and learning to be future superintendent. Willing to accept assignments in field. $6000–$7200 to start depending on experience. San Francisco, headquarters. Sj-5615.

Designer, ME or EE, 30–45; experience, in design and development of packaging machinery, machine tools, materials handling (not bulk conveyers), textile machinery; knowledge of design and development of complex machinery and electromechanical devices to do work from concept, design, through prototype fabrication and testing. For machinery manufacturer. $8400 up. San Francisco Peninsula. Sj-5606-R.

Designer, ME background, must have had recent experience in design of intricate high-speed mechanisms and machinery in packaging machinery field. Able to do design, equipment selection, and board work. For machinery manufacturer. $7200–$9600. San Francisco Peninsula. Sj-5590.

Industrial Engineer, graduate, prefer IE; solid experience with consulting-type office handling a variety of industrial projects including organizing, production, costing, and paper controls. For manufacturers, publishers, department store, newspapers, and other related business and industry. Must have broad experience and be able to make surveys, set up procedures, and handle client companies in Scandinavian countries for United States consultant. $12,000. Employer pays fee. Sj-5582.

Sales Trainee, IE or ME background, young, for one-year project training program; recent graduate, but prefer some experience in industry. Should be able to assist in competitive bidding on standard or special industrial or parts, grey iron castings and on standard items such as fire plugs, catch basins, manhole covers, and construction materials. Should also have knowledge of strength of materials and be able to read blueprints and do line drawings and assist in product development. Eventually in sales engineering. A growth position for grey iron casting foundry (80 people). $6000–$6500. San Francisco East Bay. Sj-5576.

Plant Engineer, Ch, ME, or EE, 25–30; five recent years' experience in operations or maintenance in chemically applied process plants, familiar with and able to do design sketching and to deal with operating personnel and perform supervisory operations. Should have knowledge of pumps, compressors, screens, grinders, kilns, boilers, dryers and be able to study design cost, process procedures, some knowledge of electronics and instrumentation helpful. For manufacturer. $8400. San Francisco Peninsula. Employer pays fee. Sj-5575.

Designer, at least two years' experience in design of digital data systems, EE, to design digital computor systems. $7200–$9600, depending on experience, plus profit-sharing bonuses. San Francisco East Bay. Sj-5600-R.

Manufacturing Engineer, Manager, ME background, extensive and strong manufacturing-shop background including grinding, toolroom, metalworking, automatic screw, for close tolerance precision medium to small size mechanical bearings; for high production plant. For manufacturer. $12,000, and up. Southern Calif. Sj-5569.

Field Supervisor. (*a*) ME graduate, (*b*) EE graduate; 30–50; prefer field-construction experience. For wood products manufacturer. About $8000. Housing available. Pacific Northwest. Sj-5568.

Sales Manager, mechanical background. Substantial recent experience in large quantity sales, marketing, advisory, building new sales staff. Demonstrated capability of selling and developing sales force to deal with military, manufacturing, users of precision mechanical components used in electromechanical field. For manufacturing firm. $15,000–$20,000. Apply by letter. Southern Calif. Sj-5562.

Sanitary Executive, technical graduate (possibly ChE or ME), to 55; well qualified by recent and extensive experience in technical management and administration; particularly interested in pollution experience related to functioning of public-control boards. Must have past record of staff management and administration of technical matters; including public contact, addressing public and private individuals, groups, and audiences; high-level committee meetings (technical and nontechnical); able to collect, evaluate, report, and interpret a complete body of information relating to air pollution from motor vehicles. For public agency. Submit letter of application with detailed statement of qualifications, age, availability, personnel. $17,000. Calif. Sj-5555.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after Nov. 25, 1960, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and Transfers

Alabama

●KELLEY, WILLIAM D., JR., Birmingham

California

●BUCKSBAUM, SOL, Pasadena
CORSON, GALE C., Sun Valley
GOULD, JAMES H., San Francisco
●HOLLIDAY, GEORGE H., Los Angeles
KAUNECKIS, RICHARD E., San Jose
KRIPPES, CHARLES J., Whittier
RATLIFF, GORDON I., Walnut Creek
STRAUSS, ROY L., La Canada
VALENTINE, PHILIP J., Pasadena

Connecticut

●SINCLAIR, NEIL A., Gales Ferry
JENNINGS, DAVID C., Windsor Locks
STRICKLAND, RAYMOND C., Trumbull
ALDRICH, WILLIAM J., Waterbury
HOLLEY, CHARLES K., Windsor Locks
PASS, RALPH S., Westport

Delaware

MURPHY, JOHN P., Wilmington
●O'NEILL, PHILIP P., Wilmington

●Transfer to Member or Affiliate.

District of Columbia

SIMONS, MANLEY H., JR., Washington

Florida

LEAPGREEN, J. W., Pensacola
SAMARAS, RICHARD N., Tampa
WOODS, TARLTON E., Pensacola

Georgia

●TAULMAN, JOHN M., Atlanta

Hawaii

SORENSEN, LARS K., Honolulu

Illinois

●BRYAN, ROBERT G., Chicago
ENGEL, DONALD L., Danville
HENSON, RALPH B., Creve Coeur
HITCHCOCK, STEPHEN M., Wilmette
●PALUSKA, ROY T., Washington
●STALLMEYER, JAMES E., Urbana
TANKUS, HARRY, Morton Grove
VISKANTA, RAYMOND, Argonne

Indiana

FISHER, JAMES E., Newburgh
IVERSEN, BERNT G., Connersville
LEE, BUNG-CHUNG, Evansville
SUSAT, EDWARD C., Evansville
●VOLPATTI, RAMON, Speedway

Iowa

GALLAGHER, ROBERT B., Cedar Rapids

Kentucky

●CROSS, MALCOLM A., Calvert City

Louisiana

MARTINEZ, JOHN L., New Orleans
•SOGIN, HAROLD H., New Orleans

Maryland

•LOUDEN, HARRY M., Baltimore
•RYAN, JOHN M., Baltimore

Massachusetts

BARTA, SUSHIL K., Cambridge
•CALCIO, JOSEPH A., Holbrook
FIAMM, WERNER H., Quincy
FORREST, JOHN W., West Acton
•GODSCHALL, MILTON G., East Lynn
GUZDAR, ADI R., Cambridge
•KONICK, MARVIN M., Springfield
PEARSON, EARLE B., Mattapoisett
ZUND, LEO, Wilmington

Michigan

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GREGOR, JOHN R., Detroit
•HEIDEL, CHARLES M., Detroit
HEIDMAN, PHILLIP E., Detroit
PRATT, NORMAN R., Midland

Missouri

HANSON, PHILLIP H., Independence
MOTLEY, FRANK W., Kansas City

New Jersey

•DEFUSCO, ANDREW M., Fairlawn
HUTTER, FRED L., Keansburg
PARKER, CHARLES E., Newark
SHELBY, WALLACE M., Summit

New York

AHRNS, WILBUR C., Rochester
COMBES, CHARLES L., New York
•DOWD, JOHN GERARD, New York
DUFFETT, JOHN R., Newburgh
EINBECK, AUGUST C., New York
ENGLISH, GERALD R., New York
EOLIN, ROBERT W., Corning
ESTES, HUGH, New York
FENARI, THOMAS S., Flushing
GOLDBERG, MARTIN A., Massapequa Park, L. I.
GUTIERREZ, ORLANDO A., Scotia
HERZ, JOACHIM, Jackson Heights
KIHLGREN, THEODORE E., New York
MAHONEY, JOHN CLINTON, New York
POST, JACK C., Derby
ROZANSKI, WOJCIECH S., Flushing
TURNBULL, DONALD M., Hastings on Hudson
UDELL, HARVEY, Long Island City

North Carolina

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BURNS, EDWIN C., Winston-Salem
DAVIS, ROBERT F., Winston-Salem
DICK, ROBERT LACY, JR., Belmont

Ohio

•DESTEPHEN, ALBERT M., Alliance
MEYER, CHRISTIAN, Mount Vernon
•PROBERT, PAUL B., Barberton
SMITH, RALPH D., Athens
SPRY, PHILIP A., Akron
•WHEELER, HARRY E., Toledo

Oklahoma

•McGOODWIN, BEN P., Oklahoma City

Pennsylvania

•BIRNIE, CLOTWORTHY, JR., University Park
BOETCKER, CARL H., Erie
DAHLBERG, JOHN R., Greensburg
DOOLITTLE, CHARLES, Pittsburgh
HORROBIN, PAUL M., Seneca
JOHNSTON, JAMES P., Easton
KNIGHT, CLYLAS E., JR., Media
•McGUTH, JOSEPH C., Erie
•RICCI, FRANCIS R., Laurel Dale
•SIMONIAN, TOROS M., Erie
TIMKO, CHARLES A., New Kensington
WARRINGTON, HAROLD W., Philadelphia

Rhode Island

EDWARDS, ROBERT G., Lincoln

South Carolina

•ROWE, EDGAR R., Hartsville
•McKINNEY, SPART J., Camden
•STRAUB, ROBERT C., North Augusta

Tennessee

BACHELDER, CHARLES E., JR., Kingsport
•STANEK, FLOYD J., Powell

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WOOTEN, CECIL A., London, England

OBITUARIES

William McIntosh Andrews (1910–1960?), partner, Lockwood, Andrews and Newman, Houston, Texas, died recently according to a notice received by the Society. Born, Brenham, Texas, Feb. 20, 1910. Parents, William and Mary Ellen Andrews. Education, BS(ME), Texas A. and M. College, 1931. Mr. McIntosh worked with Houston Lighting and Power Co., Houston, Texas, for two years after graduating. He conducted tests and prepared reports on steam and diesel plants for conversion to electric power, and supervised the installation of mechanical equipment. He also made tests on refrigeration systems, and recommended improvements. In 1935 he joined the present engineering consulting firm (then known as Lockwood and Andrews) as a partner, and continued in this capacity until his death. As director of the firm's general work, he conducted engineering studies, and supervised projects on water and sewerage systems, air conditioning, refrigeration plants, industrial buildings, and power plants. On one project, he spent seven months as a resident engineer in charge of construction and erection of equipment in a 2150 hp industrial diesel power plant, following its design. In his first 14 years with the firm, he helped to design and supervise about 100 comfort air-conditioning systems, several large industrial process air-conditioning systems, numerous refrigerating plants, several diesel and steam power plants, and various mechanical handling systems. This included the original design and supervision for a highly special bulk carbon black handling installation at a synthetic rubber plant. He was a registered professional engineer in the State of Texas. Mem. ASME, 1949. Member also, ASHRAE, Texas Society of Professional Engineers, State Board of Registration of Professional Engineers (Texas), NSPE, AICE, Houston Engineers Club, and Tau Beta Pi.

Robert W. Angus (1873–1960), professor emeritus, Univ. of Toronto, Canada; and consulting engineer, died, Danville, Pa., June 30, 1960. Born, St. Thomas, Canada, July 24, 1873. Father, Robert Angus. Education, Bachelor of Applied Science in Mechanical and Electrical Engineering, Univ. of Toronto, 1897; ME. Married Mary L. Menhennick (dec). Professor Angus, who was Vice-President of ASME from 1924 to 1926, was internationally known for his work in hydraulics, and did extensive consulting work on machinery and processes in connection with pumps and turbines. His writings include two textbooks, "Theory of Machines" and "Hydraulics for Engineers." His first practical experience was gained at E. Leonard and Sons, London, Canada, and in the drafting room of the Standard Oil Co., Cleveland, Ohio. After his graduation he returned to Cleveland to work on a special gas-engine design and then worked in Pittsburgh, Pa., for the Shoenberger Steel Co. In 1900, three years after graduating from the Univ. of Toronto, he went back there to receive his appointment as lecturer and head of the newly separated department of mechanical engineering. He was made a professor in 1906, and had under his direction all heat-engine and hydraulic work in the university, including the design and equipment of the mechanical and hydraulic laboratories. Through extensive travel, Professor Angus kept in touch with the most advanced engineering work in America and Europe. In addition to his college duties he conducted a large consulting practice. He pioneered in the use of models for the study of water flow and the elimination of ice troubles in hydraulic plants. He carried out the research work at the basis of the design of the intake for the Chippawa-Queenston Power Plant at Niagara Falls. In 1942 he won the American Water Works Association's George Warren Fuller Award for his contributions to research. He wrote many engineering papers. Jun. ASME, 1901; Mem. ASME, 1908; Fellow ASME, 1936; Hon. Mem. ASME, 1940. He helped form the Ontario Local Section of ASME, and was active in the Hydraulic Division. From 1924 to 1926 he served as Vice-President of the Society. He also held honorary membership in the Engineering Institute of Canada, the Institute of Mechanical Engineers (London), and the Canadian section of AWWA. He was a registered professional engineer in Ontario and past-president of the Association of Professional Engineers of Ontario. Surviving is a son, Leslie R. Angus, Danville, Pa., a grandson, and a granddaughter.

Bertram Lawrence Bailie (1888–1960), consulting engineer, died, June 10, 1960. Born, Scranton, Pa., July 2, 1888. Parents, Bertram James and Amelia Margaret (White) Bailie. Education, attended Detroit Institute of Technology; and Michigan State College. Married Caryl Scovel, 1910; children, Dorothy E., Carolyn S., Bertram L. Jr., Howard H., and Charles G. A structural engineer, Mr. Bailie gained his early experience as a draftsman on structural design, piping, heating, and other general engineering work, with Harry J. Darling, Detroit, Mich. Two years later, while with Donaldson and Meier, Detroit, he was made chief draftsman; and four years later started with John Finn and Son, general contractors of Detroit, as superintendent, advancing finally to manager. The company dissolved on the death of its owner in 1927, and Mr. Bailie went into private building enterprise for two years. Then he joined Bryant and Detwiler Co., as a supervising engineer. One of his first responsibilities concerned the refrigerating and other mechanical equipment for the eight-story Grand Trunk Warehousing Building in Detroit. During his seven years with the company, he also worked on projects involving the Detroit Institute of Arts, Harper Hospital, and the produce terminal for the Wabash Railroad. He went to Peoria, Ill. in 1933 to supervise construction of part of the Hiram Walker Peoria Distillery, the larges beverage distillery in the world, and joined the company as a construction engineer in '934. He became a research engineer in the produ tion department in 1935, and then plant enginee with supervision of engineering work and charge of maintenance. He retired from the company in 1953 and, after a short vacation period, went on his own as a consulting engineer. Mem. ASME, 1939. Member also, Detroit Engineering Society. He wrote several papers on factory maintenance. He was a licensed engineer in the states of Illinois, Michigan, Maryland, and New York.

Rudolf Robert Beckmann (1903–1960), manager, New York district sales, Combustion Engineering, Inc., died, Manhasset, L. I., N. Y., July 7, 1960. Born, Bayonne, N. J., April 24, 1903. Education, attended Cooper Union. Mr. Beckmann was associated with Combustion Engineering, Inc., New York, N. Y., for 35 years in engineering and sales capacities. He joined the engineering department in 1925, working on boiler design. By 1928, he was supervising design procedures, and in 1943, was in the proposition engineering department doing proposal and contract writing, and estimating. He joined the sales department in 1939, and was made New York district sales manager in 1956. Assoc. Mem. ASME, 1927; Mem. ASME, 1959. Surviving are his wife, Veronica; a son, Donald M.; two brothers, Alfred and Alexander, Westfield, N. J.; and a sister, Mrs. Albert Dunn, St. Petersburg, Fla.

Ernest L. Browe (1891–1960), retired designing engineer, died, March 7, 1960. Born, Detroit, Mich., Oct. 27, 1891. Parents, Robert J. and Jessie R. (Wilkinson) Brow. Education, attended Wayne Univ. and Pennsylvania State College; BS, Michigan State College, 1915. Married Elsie L. Matteson, 1916; children, James D., Shirley E., Marjorie J., Edith, and June F. Mr. Browe specialized in industrial power-plant design. He gained early experience as a tool and fixture designer for several firms between 1910 and 1916, while completing his education. Then he was a draftsman on power-plant construction with Detroit Edison Co., Detroit, Mich.; and on plant maintenance and construction with International Smelting Co., Tooele, Utah. In 1919 he was an assistant power-plant designing engineer at the Rouge plant of the Ford Motor Co., Michigan. Thereafter he continued to gain experience in power-plant design with several other firms, among them Solvay Process Co., Syracuse, N. Y., 1925–1928; Babcock-Wilcox-Goldie McCullough Ltd., Ontario, Canada, where he was chief draftsman and engineer, 1928–1933; Electric Bond and Share Co., New York, 1935–1936; and Celanese Corp. of America, Cumberland, Md. His work involved the design of power plants and their steam, water, and electrical services, and the design and servicing of boilers, stokers, and furnaces. With the Celanese Corp. of America he had charge of modernizing the boiler plant and designing the turbo-generator plant. Assoc. Mem. ASME, 1921; Mem. ASME, 1936. He was a licensed engineer in the State of Michigan.

Clinton Bleecker Brown (1888–1960), consulting engineer, died, Staatsburg, N. Y., May 25, 1960. Born, New York, N. Y., April 1, 1888. Parents, Thomas Ellis and Florence (Bleecker) Brown. Education, attended Columbia University School of Mines. Married Erzébet Duma de Vaida Hunyad, 1912; children, Clinton B. D., and James Clinton D. Mr. Brown worked with all phases of consulting engineering, including industrial, management, design, construction, and mechanical aspects. He started as a draftsman with Otis Elevator Co. in 1910, subsequently going to Hamburg, Germany, where he erected elevators in the Elbe Tunnel; to Berlin; and to Budapest, Hungary, where he had charge of a branch office. He returned to the New York office in 1913 as an assistant to Thomas E. Brown, consulting engineer in the designing, building, and testing of experimental machines, and special elevator work. In 1915 he became an apprentice on shops and erection at the Worthington Pump and Machinery Corp., Harrison, N. J. During World War I, he spent two years with the U. S. Army, during which he was a Captain in command of gun-plant construction and operation in Bethlehem and Philadelphia districts. Then he studied export work with the Allied Machinery Company of America, afterward becoming chief engineer with Erdman Forced Draft Burner Co., where he was from 1920 to 1923. In 1923 he oined Ford, Bacon and Davis, Inc., New York, N. Y., as an engineer, staying with them until 1953, when he went into private consulting practice. Assoc. Mem. ASME, 1917; Mem. ASME, 1935. Member, also, Society of American Military Engineers. He was a registered engineer in the states of New York, New Jersey, Rhode Island, and Wisconsin.

Thomas Johnson Cook (1888–1960), retired mechanical engineer, died, June 17, 1960. Born, Union City, Ohio, March 21, 1888. Parents, Thomas Huskinson and Rachel (Johnson) Cook. Education, attended Univ. of Wisconsin; graduate in ME, International Correspondence School. Married Elizabeth Odean Locke, 1933; one son, Thomas Johnson, Jr. Mr. Cook was with General Motors Corp. for many years, and before his retirement held executive positions, including president, with McKinnon Industries Ltd., a subsidiary of General Motors. He received his early training as an apprentice mechanic for four years with the New York Central Railroad in Bellefontaine, Ohio In 1910 he became an air brake instructor with the railroad, and in 1911 was a foreman, draftsman, and tool designer. Two years later he was foreman of machine shops with the Lima Locomotive Corp., Lima, Ohio, where he stayed for six years. Subsequently, he went with Garford Motor Truck Co., Lima, where he was assistant production manager for three years, and then planning manager. He also was a member of the factory advisory board. From 1923 to 1925 he was with Fairbanks, Morse and Co., Beloit, Wisconsin, as assistant superintendent of the production engineering division, and later, superintendent of methods and equipment. In 1925 he began his long career with General Motors Corp., when he joined Delco Products Co., Dayton, Ohio, as a process engineer. He was successively plant engineer and superintendent of the commercial motor division. He was appointed factory manager of General Motors Radio Corp., Dayton, Ohio, in 1929, a post he held until 1931, when he became assistant factory manager of The McKinnon Industries Ltd., St. Catherines, Ontario, Canada. In 1932 he became superintendent of the Delco Division, and assistant plant manager; was appointed factory manager in 1941; and was elected president and general manager, effective Jan. 1, 1943. He was retired in Lewiston, N. Y. Mem. ASME, 1924. He is survived by his wife.

Allen S. Crocker (1874–1960), consulting engineer, died, Rochester, N. Y., Feb. 15, 1960. Born, Chelsea, Mass., Jan. 9, 1874. Parents, Benjamin F. and Pheobe A. Crocker. Education, BS, Massachusetts Institute of Technology, 1897. Married Marion E. Scrantom, 1907. After graduating in 1897, Mr. Crocker worked with the Blake Knowles Steam Pump Co., East Cambridge, Mass., where he developed a chemical laboratory for analyzing pig iron and coke, purchasing pig iron on analysis for the foundry. For several months he also was director of trade schools, Elmira Reformatory, Elmira, N. Y. In 1899 he went to the Mechanics Institute, Roch-

ester, N. Y. as an instructor and superintendent, while carrying on a consulting engineering practice. He taught at the institute for 20 years, resigning in 1919 to manage his increasingly successful consulting practice. This concerned the design of industrial power plants, and heating, ventilating, and electrical systems for factories, hotels, schools, hospitals, and other buildings. He also was associated with Gordon and Kaelber, architects, Rochester, and helped to build the University of Rochester, including the Strong Memorial Hospital and Medical School, the staff house, nurses home, and research building, as well as the municipal hospital of Rochester. His work also included the heating, ventilating, and water circulatory systems for Benjamin Franklin Junior and Senior High School, Rochester. He did work for Delco division of General Motors during this period, and was a member of a committee to study the New York State boiler code for the Rochester Chamber of Commerce. In addition, he authored a book on steam engineering. Mem. ASME, 1905. He was a registered professional engineer in New York State. He is survived by his wife.

Frank Lawrence Davis, Jr., (1882–1960), retired development engineer, died, Alexian Brothers Hospital, Elizabeth, N. J., August 10, 1960. Born, New Bedford, Mass., Jan. 13, 1882. Parents, Frank Lawrence and Alice Evelyn (Borden) Davis. Education, Mechanic Arts High School, Boston, Mass.; attended Lehigh Univ. Married Josephine Smith, 1912; children, Paul, Anna (dec), Ralph, Constance, Albert, and Bruce. Mr. Davis was employed for 30 years as an engineer with Watson-Stillman Co., Roselle, N. J., manufacturers of hydraulic machinery. His work concerned hydraulic presses, pumps, valves, and injection-moulding machinery. He also developed a complete line of swash-plate pumps. Mr. Davis began his career in the hull departments of the Fore River Ship and Engine Co. and the Fore River Shipbuilding Co., Quincy, Mass., which later became the Bethlehem Shipbuilding Corp. He was in charge of hull engineering for various companies for eight years; and of armor design for 12 years. He gained further experience in shipbuilding with Holmes Motor Co., Mystic, Conn., on gas engine and boat design, 1906–1910; Newburgh Shipyards Inc., in charge of hull engineering, 1919–1921; Bethlehem Shipbuilding Corp., Bethlehem, Pa., 1921–1922; and the Moore Plant of the Bethlehem Shipbuilding Corp., Elizabeth, Pa., 1922–1925. He was a member of the Naval Architects Society while in the shipbuilding business. He joined Watson-Stillman Co. in 1925, and in 1928 was appointed engineer in charge of development. From 1935 to 1937, he also was associated with Worthington Pump and Machine Co., Harrison, N. J., working on the design of reciprocating pumps. He retired in 1955, after also having been associated with H. K. Porter Co., Inc., New York. He held several patents on hydraulic pump mechanisms. Mem. ASME, 1930. Surviving are his wife, four sons, a daughter, and 17 grandchildren.

Ellis La Verne Dewey (1923–1960), engineer, Procter & Gamble Co., Cincinnati, Ohio, died, July 12, 1960. Born, Des Moines, Iowa, May 16, 1923. Education, BS(ME), Iowa State College, 1947. Mr. Dewey joined Procter & Gamble Co. after his graduation. He was an engineer in the process-equipment development department, working on continuous soap-making equipment. His work included the design of pressure vessels, evaporators, heat exchangers, vacuum equipment, and pumps. Assoc. Mem. ASME, 1948.

Theodore Heberton Doan, Jr., (1890–1960), chairman of the board, The Foote-Burt Co., Cleveland, Ohio, died, July 8, 1960. Born, Philadelphia, Pa., Oct. 10, 1890. Parents, Theodore H. and Martha B. (Snodgrass) Doan. Education, ME course, International Correspondence School. Married Margaret Pratt, 1915; children, Molly L. and Constance S. Married Opal V. Watson, 1939. Mr. Doan joined The Foote-Burt Co., machine-tool manufacturers, as an apprentice in 1906. He advanced through various company positions to become president in 1933, spending 54 years with the organization. As a machinist apprentice, he designed a special drilling machine. When he finished his apprenticeship in 1909, he did office sales work, and in 1911 became a traveling salesman selling special drilling machines. He went back to office sales work in 1914, becoming in quick succession, purchasing agent, factory manager and, in 1919, vice-president in charge of the shop, engineering, and sales departments. He held that position until he became president. Patents were issued to him on drilling, tapping, and surface-broaching machines. Mem. ASME, 1928. He did work on the ASME Standards Committee.

William Waterman Gaylord (1884–1959), consulting engineer, firm of William W. Gaylord, Torrington, Conn., died, November, 1959. Born, Torrington, Conn., Oct. 30, 1884. Parents, Hubert Giles and Isabelle Annette (Waterman) Gaylord. Education, BS(ME), M. I. T., 1906. Married Mildred Chase Foye, 1912; children, William Waterman, Jr., and Alan Chase. Mr. Gaylord specialized in steam power-plant design. He started as a draftsman in the power division of the American Brass Co., Waterbury, Conn. There he worked with the installation and erection of power generating, transmission, and other types of brass mill machinery. While with the company, he was transferred several times, working successively in the furnace division, on the design of melting, annealing, and reheating furnaces for brass and copper; the power division, where he returned in 1909 to work on boiler-plant design; and the Coe Brass Branch, Torrington, as chief draftsman on the erection of annealing furnaces and mill alterations. He helped to supervise the erection of several plant additions. In 1923 he went with Westcott and Mapes, Inc., New Haven, Conn., as a mechanical engineer on the economics of steam and power production in industrial and utility plants. He became a consulting engineer on industrial power heating and material handling in Hamden, Conn., in 1932. For several years he also taught physics and heat power engineering at Bridgeport Engineering Institute. He wrote many articles on industrial power problems for technical publications, and was a registered professional engineer in the State of Connecticut. Jun. ASME, 1914; Assoc. Mem. ASME, 1919; Mem. ASME, 1926.

Carlos E. Harrington (1893–1960), chief engineer, Winfield H. Smith Corp, Springville, N. Y., died, Jan. 7, 1960. Born, Buffalo, N. Y., Feb. 9, 1893. Parents, Andrew Elmer and Elizabeth (Lambrix) Harrington. Education, ME, Cornell Univ., 1918; MS, Univ. of Buffalo, 1925. Married Vertie K. Slattery, 1921; children, Vertie Elizabeth, Carlos Elmer, Jr., Jean Marie, Patricia Ann, Mary Ellen. Mr. Harrington was a teacher, engineer, and consultant in the field of machine design with experience on a variety of design subjects. He served his apprenticeship from 1909 to 1918 with the American Radiator Co., Buffalo, N. Y., at the same time teaching machine design for a few years at Cornell University. In 1918, having completed his apprenticeship, he filled in rapid succession the posts of assistant teacher in shipfitting school at Harlans and Hollingsworth Corp., Wilmington, Del.; mechanical designer on the battleship "Lexington" with Bethlehem Shipbuilding Corp., Bethlehem, Pa.; and assistant foreman in charge of layout work in the metal-pattern shop of American Radiator Co. From 1920 to 1927 he taught mathematics and engineering at the Univ. of Buffalo, and in 1927 became assistant to the Dean of the school of engineering. He was a consultant with National Colloids Corp., Buffalo, in 1928, supervising the design and construction of colloid mills and other process machinery, and at the same time, a consultant on the construction of stroboscopes with Niagara Engineering Research Corp. From 1929 to 1939 he was successively a consultant and associate with Uebelhoer Brothers, Buffalo; a consultant on hydraulic equipment with Vickers Mfg. Co.; and an engineer on hoisting equipment with Columbus McKinnon Chain Corp., Tonawanda, N. Y. He was in charge of designing three World's Fair amusement devices, the aerial joy ride, the drivadrome, and the bob sled, for Spillman Engineering Corp. in 1938. For several years he also tutored for the New York State professional examinations, in association with the Engineering Society of Buffalo. During the years from 1940 on, he was a lecturer in mechanics at the Cornell University College of Engineering; senior project engineer with Paragon Research, Inc.; and chief engineer, Amphibian Car Corp., Buffalo. He became director of Aetna Permanent Savings and Loan Assn., in 1936, and was secretary from 1937 to 1940. He became a member of the Consulting Engineer Chisholm Moore Hoist Corp., Tonawanda, in 1937. He authored "Introduction to Mechanical Drawing." Mem. ASME, 1926. He was a past Chairman of the ASME Process Industries Division, and Chairman and Treasurer of the Buffalo Section of ASME. Member also, MAA, and past director of the Engineering Society of Buffalo. He was a registered professional engineer in New York State.

William August Heinze (1907–1960), senior engineer, Ingersoll-Rand Co., St. Louis, Mo., died, August 3, 1960. Born, Joliet, Illinois, 1907. Parents, William Anton and Nelly Florence (Woelfersheim) Heinze. Education, BSME, Univ. of Illinois, 1930. Married Kathryn Inez Keyler, 1934. Mr. Heinze began a long career with Ingersoll-Rand Co., in 1930 in the company shops at Phillipsburg, N. J.; Easton, Pa.; Painted Post, N. Y.; and Athens, Pa., working on the assembly and erection of all types of company equipment. His work concerned air and gas blowers, compressors, condensers, diesel and gas engines, and rock drilling equipment. He also spent a period in engineering departments in the New York office studying applications of this equipment to industrial problems. From 1931 to 1934, he was an engineer in the Cameron Pump Division of Ingersoll-Rand, working with special engineering problems of the oil, chemical, and paper-mill industries. He was with E. S. Hammond Co., Bloomfield, N. J., 1934–1936, as a combustion engineer designing fireboxes, and boiler settings for water-tube and horizontal-return tubular boilers. As an engineer in the compressor department of Ingersoll-Rand, 1936–1937, Mr. Heinze worked with special problems requiring reciprocating compressors, such as propane refrigeration cycles for the oil industry. From 1937 to 1939 he worked with engineers from the companies involved to solve pumping and condensing problems in new plant designs for Du Pont, Hercules Powder, Atlas Powder, Socony-Vacuum Oil Co., Philadelphia Electric Co., Sun Shipbuilding Co., and Sinclair Refining Co. Except for a four-year period as an officer in the U. S. Army, he worked with many other broad industrial engineering problems during his career. As an army officer from 1942 to 1946, his engineering training earned him two important assignments. He trained an engineer heavy-shop company, consisting of machine, welding, and carpenter shops, a foundry, and a repair platoon, to repair wrecked equipment for the Engineer Corps. This company was the first of its kind to go overseas. Later, he was appointed as battalion commander to train and go overseas with the 358th Engineer General Service Regiment. In England, during the Battle of Britain, this regiment built air fields, advance repair depots, and other facilities. Mem. ASME, 1948. Member also, ASHRAE.

Frederick H. Hoge (1884–1960), retired mechanical engineer, died Jan. 4, 1960. Born, Bellefontaine, Ohio, Jan. 3, 1884. Education, BSME, Ohio Northern Univ., 1908. Mr. Hoge specialized in power transmission machinery and speed reducers for decreasing electric motor speeds. He had a long career, 1917–1951, with W. A. Jones Foundry and Machine Co., Chicago, Ill., where he first had charge of the engineering and speed reducer departments, and where he eventually became president. He designed the Jones spur-gear speed-reducer. Before joining that company, he worked with several Ohio and Illinois firms, among them Lane and Bodley Co., Cincinnati, Link Belt Co., Webster Mfg. Co., Sullivan Machinery Co., and Green Engineering Co., Chicago. He started as a draftsman with the Bellefontaine Foundry and Machine Co., two years before entering the university. Before retiring, he also worked with Hewitt-Robins, Inc. Mem. ASME, 1921.

Bernard Joseph Jaffa (1923–1960), designer, Bailey Meter Co., Wickliffe, Ohio, died June 12, 1960. Born, Cleveland, Ohio, Feb. 12, 1923. Education, BME, Fenn College, 1949. Mr. Jaffa was with Certified Equipment Co., Cleveland, as a draftsman for a short period in 1947. He joined Bailey Meter Co., Cleveland, upon completing his education in 1949. He was a junior designer and then a designer on recording and controlling meters for boilers. Assoc. Mem. ASME, 1949. Surviving is his father, Mr. F. R. Jaffa.

Frank Kullmer (1901–1960), vice-president and director, Soule' Steel Co., San Francisco, Calif., died, Kassel, West Germany, July 11, 1960. Born, Helsa-Kassel Germany, Nov. 3, 1901. Parents, Ludwig and Elizabeth Kullmer. Education, attended Vogt Engineering School, Kassel, Germany. Naturalized U. S. citizen, San Francisco, 1930. Married Else A. Ganns, 1925. Mr. Kullmer held his first position as an engineer from 1918 to 1921 with Josef Linker, Kassel Wilhelmshoehe, Germany on construction design. By 1925 he had emmigrated to San Francisco, and was working with United States Metal Products Co., as a designing engineer. Four years later he joined Soule' Steel Co., manufacturers of iron and steel products, and as chief engineer, was placed in charge of engineering in the steel window and door department. Later, he also worked on the design of prefabricated houses and shipbuilding. He died in West Germany while on a business trip for the company, of which he was then vice-president. He held patents on metal window construction. Assoc. Mem. ASME, 1932; Mem. ASME, 1935.

Harold Alburn Lockhart (1906–1959), chief engineer, Bell and Gossett Co., Morton Grove, Ill., died, November, 1959. Born, Nashville, Tenn., March 25, 1906. Parents, George Lionel and Katherine Lockhart. Education, BME, Univ. of Minnesota, 1929. Married Erna Bertha Krumvieda, 1934; child, Elizabeth Joann. After graduating, Mr. Lockhart went with The Insulite Co., Minneapolis, Minn., as a research engineer on the design of pulp machinery, insulation-board felting machinery, and heat-transfer test work. In 1930 he was an engineer in charge of design and production of industrial stokers with Stott Stoker Co., St. Paul, Minn., where he stayed for two years. In 1934, after two years away from engineering work, he joined Bell and Gossett Co., Chicago, Ill., as chief engineer in charge of design and production of hot water heating specialties. Mr. Lockhart saw Bell and Gossett Co., grow from a minor factor in the hot water heating industry to a yearly volume, by 1942, of three million dollars. He was instrumental in developing the company's industrial heat-transfer division in oil cooling. Under his direction, the engineering department applied unconventional methods to the handling of oil quenching problems. Overcoming sales resistance to these methods, the company eventually supplied defense corporations with oil-quenching systems. Mem. ASME, 1942. He did committee work with the Society on the Safety Valve Requirements Subcommittee of the Boiler and Pressure Vessel Committee. Member also, ASHRAE. He was a registered professional engineer in Illinois.

Jack Simmons Lough (1914–1960), chief engineer, Richmond Engineering Co., Richmond,

Va., died, Jan. 10, 1960. Born, Elkins, West Va., Dec. 1, 1914. Education, BSME, Virginia Polytechnic Institute, 1938. Mr. Lough was with the Richmond Engineering Co., Inc., Richmond Va., from 1938 to 1942 as head of the company's heat-exchange division. He supervised the processing and designing of water-storage pressure vessels, heaters, and shell and tube heat exchangers. During the war years, he was a company commander in the U. S. Army Corps of Engineers, supervising construction projects. In 1945 he returned to the Richmond Engineering Co. as chief draftsman and heat-exchange engineer, becoming assistant chief engineer in 1946, and chief engineer in 1951. Mem. ASME, 1954. Member also, National Society of Professional Engineers. He was a registered professional engineer in the State of Virginia.

Douglas Bruce MacLaren (1900–1960?), construction engineer, District of Public Works, U. S. Navy, Pearl Harbor, Honolulu, Hawaii, died recently according to a notice received by the Society. Born, San Francisco, Calif., May 4, 1900. Education, BS, McGill Univ., Montreal, Canada, 1923; BS(ME), Univ. of Chicago, 1929. Mr. MacLaren held a variety of positions as both an electrical and a mechanical engineer throughout his career. He started in 1923, working with Pierson-Wilcox Co., electrical contractors, on electrical and mechanical construction in various parts of Canada. After earning his mechanical engineering degree in 1929, he went with the Illinois Power and Light Corp., Chicago, as an assistant electrical engineer. Thereafter, his knowledge and skills took him to many states of the union, as well as the District of Columbia, South America, and Alaska. He was an assistant engineer and estimator, Keller Construction Co., Milwaukee, Wis., 1931–1935; a mechanical engineer, Avarillo Mining Co., Tegucigalpa, Honduras, 1936–1938; and an engineer with the division of Rural Electrification, National Mexican Government, 1938–1940. He was an electrical engineer in the Canal Zone in 1942. During World War II, he was with the Transportation Corps, U. S. Army, as chief electrical and mechanical engineer; and in Washington D. C., from 1947 to 1948, he was an electrical engineer at the headquarters of the Strategic Air Command. From 1948 to 1950, he was chief engineer on mechanical design, BuDocks, Base Development, Guam, M. I., and from 1951 to 1953 was chief mechanical engineer, Corps of Engineers, Anchorage, Alaska. He joined the Bay Exploration Co., Alameda, Calif., in 1953 and as a mechanical engineer was concerned with mining work in Utah and Colorado until 1956. Mem. ASME, 1958. Member also, AIEE. He was a registered professional engineer in the State of California.

Robert Lewis Morgan (1927–1960), power and maintenance supervisor, E. I. du Pont de Nemours and Co., Inc., Ottawa, Ill., died, Billings Hospital, Chicago, July 8, 1960. Born, Lykens, Pa., May 31, 1927. Parents, John T. and Kathryn (Welker) Morgan. Education, BS, Lafayette College, 1950. Married Mildred Keiser, 1951. Before completing his college education, Mr. Morgan received engineering training as a student aide in industrial engineering in the Gage Lab, Frankford Arsenal, Philadelphia, Pa. At his death, he was with the explosives department of the du Pont Company. Assoc. Mem. ASME, 1950. Surviving are his wife; a son, Robert J.; a daughter, Kathlyn; and a brother, John T. Morgan, Jenkintown, Pa.

William R. Paull (1900–1960), co-owner, Valley Pump and Drilling Co., Salinas, Calif., died, June 21, 1960. Born, Alameda, Calif., August 1, 1900. Mr. Paull specialized in hydraulics. He gained his early experience with Byron Jackson Co., Berkeley, Calif., in held installations and testing, becoming a draftsman in 1925. He became a sales engineer for the company in 1927, and was in charge of all sales and installations in the east San Francisco Bay district and the northern California coast counties. Assoc. Mem. ASME, 1930; Mem. ASME, 1942.

Harry Martin Perry (1869–1960?), retired mechanical engineer, died recently according to a notice received by the Society. Born, Ridgeway, Pa., Feb. 2, 1869. Parents, Joseph and Alice Perry. Education, correspondence and home study in mechanical engineering. Married Jessie Haslett, 1904. A specialist in belt power transmission, Mr. Perry began his career in 1886 as a stationary engineer doing work in northern Ohio stone quarries. While in his early twenties, he obtained a high-grade stationary engineer's license to operate within the city of Cleveland. In 1890 he took a small position with Ingersoll-Sergeant Drill Co., Cleveland (now Ingersoll-Rand Co.), later becoming a salesman on the installation and adjustment of air lift pumping plants. His work concerned areas in the United States, Mexico, and Russia. He also was a branch-office manager in El Paso, Texas; Boston, Pa.; and Birmingham, Ala. He was a secretary-engineer with National Compressed Air Machinery Co., Los Angeles, Calif., and a sales engineer representing the Union Steam Pump Co., before starting his own business in 1921. This he began by contracting complete compressed-air plants, which lead to the development of slack-belt idlers for his own use. However, his combination of motor attachment and new design features attracted the attention of others requiring such equipment, and he gradually built the business into a machine shop with publicity and sales organization. Assoc. Mem. ASME, 1920; Mem. ASME, 1929. He worked on the ASME Executive Committee. He was a member of AAE and Mechanical Power Associates. He is survived by his sister, Merle Perry.

William Arthur Ramsay (1876–1960?), retired mechanical engineer, died recently according to a notice received by the Society. Born, Port Hill, Prince Edward Island, April 17, 1876. Education, high school. Mr. Ramsay had many years' experience with sugar-house machinery in the Hawaiian Islands as a chief engineer with companies on the islands of Hawaii and Oahu. He was responsible for erecting a complete factory for Hawi Mill and Plt. Co., Hawaii; and installing a complete pumping station for Ewa Plt. Co., Ewa, Oahu. He also spent many years with Catton, Neill and Co. Ltd., Honolulu, as a shop foreman, superintendent, and manager. He gained his early experience with Hugh Ramsay Shipbuilding Works, Perth Amboy, N. J., where he was an apprentice machinist; Hall Mfg. Co., Summerside, P. E. I.; Newport News Shipbuilding and Dry-Dock Co.; and Atlantic Works, Boston, Pa. He was retired in Honolulu. Mem. ASME, 1917

S. Wellford Randolph (1892–1960), chief engineer, Koppers Co., Inc., Baltimore, Md., died, May, 1960. Born, Chicago, Ill., August 5, 1892. Education, CE, Univ. of Virginia, 1915. Mr. Randolph joined Isham Randolph and Co., in 1915 as a resident harbor engineer on the designing and construction of reinforced concrete docks and a deep water channel for the City of Miami, Fla. In 1918 he began working with the Bartlett Hayward Co., Baltimore, Md., as superintendent of the blacksmith shop, and by 1923 was superintendent in the machine shop. He continued working alternately with this company and with Koppers Co., Inc., from 1926 to 1937, during which period the former company was absorbed by the latter. He held positions as field erection superintendent, field service engineer, development engineer, and sales engineer, working on blast furnace gas washers, vacuum thickeners and filters, and other projects. In 1937 he was placed in charge of engineering on oil film bearings for Koppers Company. From 1941 to 1948 he was successively in charge of ship and aircraft propeller manufacture. He was assistant chief engineer in the electrostatic precipitator department in 1948, becoming chief engineer of the department in 1949. He wrote several papers on gas and propellers. Mem. ASME, 1954. Member also, Eastern States Blast Furnace and Coke Oven Association. He was a registered professional engineer in Maryland.

William Allen Records (1915–1960), district chief engineer, Mutual Boiler and Machinery Insurance Co., Cleveland, Ohio, died, April 22, 1960. Born, Covington, Ky., Oct. 2, 1915. Education, attended Univ. of Cincinnati, and Ohio Mechanics Institute. Mr. Records was employed in 1942 by the Columbia Power Station of the Cincinnati Gas and Electric Co., in connection with boiler and turbine operation. He joined the Mutual Boiler Insurance Co., in 1943 as a supervising inspector on boiler and pressure vessel design, helping to eliminate unsafe conditions in power equipment. Assoc. Mem. ASME, 1950. He was a member of the National Association of Power Engineers, and was a licensed stationary engineer in Ohio.

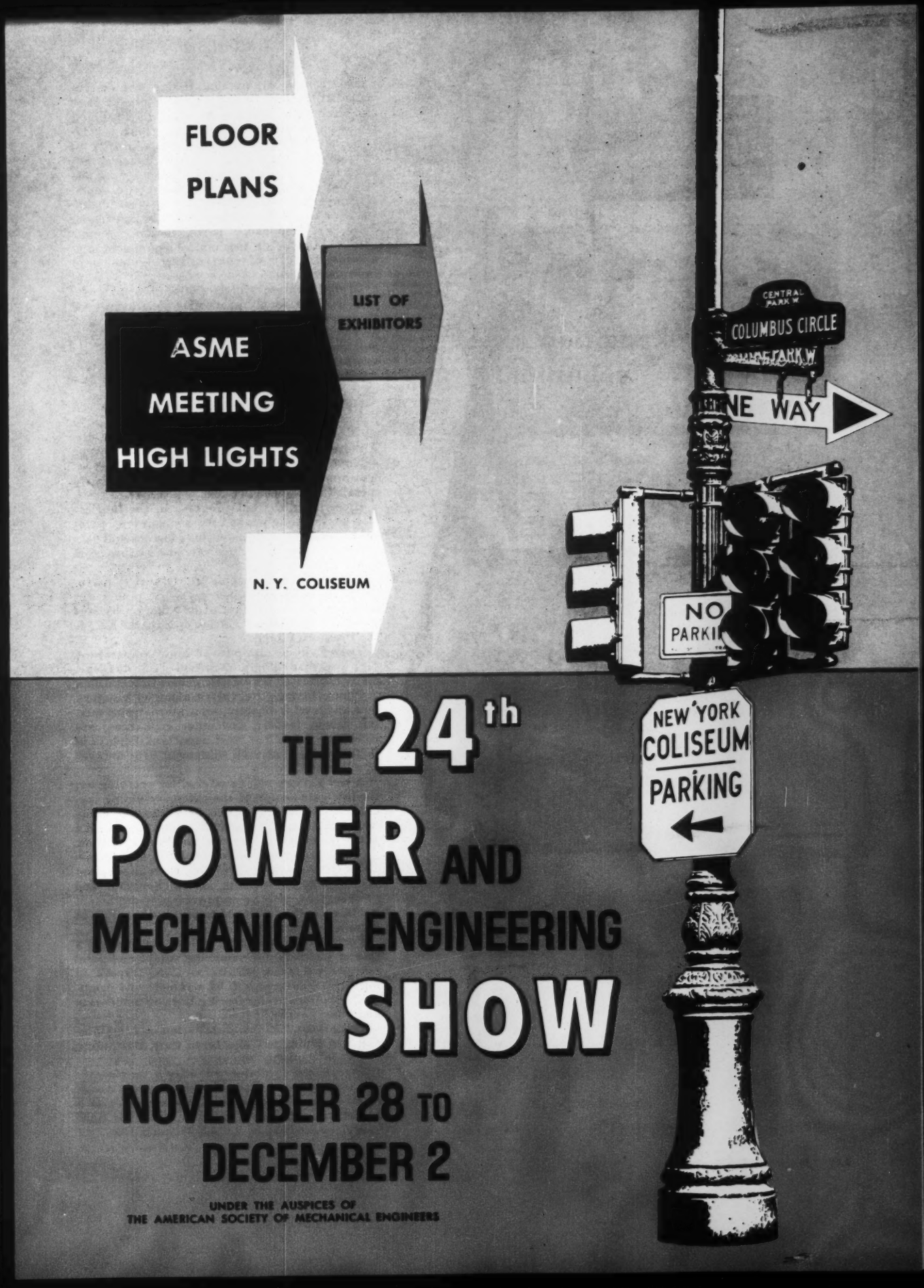
Joseph Elsworth Rogers (1898–1960), president, Standard Radio Ltd., Toronto, Ontario, Canada, died, June 14, 1960. Born, Toronto, Canada, August 30, 1898. Parents, Albert S. and Mary Rogers. Education, BS, Haverford College, 1921; BS, M. I. T., 1923. Married Helen James (dec), 1923; children, Elizabeth and Stephen. Mr. Rogers held his first position after graduation with the lubricating industry. He went with the Imperial Oil Co., Ltd., of Canada, working in the company's Sarnia refinery. While acquainting himself with the company products, he also did some work with lubricating oils, designing for the experimental plant, and testing for the engineering department. In 1925 he joined Rogers Majestic Corp., Toronto (formerly Standard Radio Co.), as vice-president. He had charge of production and sales of radio receiving sets and vacuum tubes. The firm also operated a broadcasting and a finance company. He became president of the corporation in 1939. During the war years, he was a pilot in the Royal Canadian Air Force, returning to the radio business as president of Standard Radio Ltd., a holding company, in 1945. Junior ASME, 1924; Assoc. Mem. ASME, 1933; Mem. ASME, 1935. He was a member of the Society of Industrial Engineers.

Norbert H. Schickel (1886–1960), consulting engineer, Ithaca, N. Y., died, Tompkins County Hospital, at Ithaca, July 30, 1960. Born, New York, N. Y., July 28, 1886. Education, ME, Cornell Univ., 1909; PhD, 1933. Mr. Schickel attained a reputation as a builder and designer in the 1930's, after completing his post-graduate work, by constructing apartments and a housing development in Ithaca. He exhibited practical engineering talent before entering college in 1905 by building several small electric motors and a gas engine. During his college years, he designed, built, and successfully operated one of the first two-stroke motorcycle engines, as well as a four-cylinder V-type, air-cooled, air-scavenging, two-stroke motor. In 1909, after graduating, he went to work for the H. H. Franklin Mfg. Co., motor car manufacturers in Syracuse, N. Y., doing experimental design. On his own he designed and developed a motorcycle that was later manufactured by the Schickel Motor Co., which he organized in 1911 in Stamford, Conn. As president of his new company, he increased its original capital of $10,000 to $100,000 between 1911 and 1920. The plant was converted during the war to manufacture parts for the Liberty Motor and then was returned to motorcycle production. Mr. Schickel returned to Cornell Univ. in 1927 to do post-graduate research, receiving his PhD in 1933. He designed and built Fairview Manor, an apartment house, in 1937. Later he built a residential area, and then Elmcrest Circle, a housing development. Some years afterward he passed an examination to become a licensed electrician. Mem. ASME, 1921. He was a member of SAE, the Ithaca Board of Realtors, National Association of Housing Officials, National Housing Conference, Urban Land Institute, and the American Concrete Institute. He was a director of the National Association of Home Builders, and a past president of the Home Builders Association of the Finger Lakes Inc. Surviving are six sons, Norbert H., Jr., of Dryden, William J. of Loveland, Ohio, Hubert C. of Malone, John of Lavonia, Mich., and Louis E. and Gerald P.; two daughters; Mother Ruth Schickel of the Mesdames of the Sacred Heart of Newton, Mass., and Miss Marie Schickel; 33 grandchildren; and four sisters, Miss Agnes Schickel, Miss Bertha Schickel, and Mrs. Bruno Benzinger, all of New York City, and Mother Gertrude Schickel of Hyogo-Kiev, Japan.

William Wallace Sprague (1895–1960?), sugar refinery executive in the states of Georgia and Louisiana, died recently according to a notice received by the Society. Born, Burlingame, Calif., August 23, 1895. Parents, Richard Homer and Isabelle (Wallace) Sprague. Education, BS, Univ. of Calif. at Berkeley, 1917. Married Mary Swan Crowther, 1924; children, Isabel, William, and Mary Swan. Mr. Sprague had a long career in the sugar refining industry. Upon terminating a period as first lieutenant with the U. S. Army Corps of Engineers in 1919, he spent a year on underground surveying in the engineering department of Inspiration Copper Co., Miami, Ariz., and then joined Savannah Sugar Refining Corp., Savannah, Ga. as an assistant superintendent. He rose through several positions in the engineering department and refinery, becoming executive vice-president and director in 1944. He also became president and director of the Adeline Sugar Factory Co., Ltd., Jeanerette, La., in 1924; and vice-president and director of Atlantic Towing Co., Savannah, in 1946. Mem. ASME, 1928.

William Thomas Todd II (1933–1960?), sales engineer, Somers, Fitler and Todd Co., Pittsburgh, Pa., died recently according to a notice received by the Society. Born, Pittsburgh, Pa., Sept. 11, 1933. Education, BS(ME), Univ. of South Carolina, 1955. Mr. Todd went with Carbide and Carbon Chemicals Co., South Charleston, West Va., after graduating, working in the gas process and development engineering department. Later he joined Somers, Fitler and Todd Co. Assoc. Mem. ASME, 1958. He is survived by his brother, Kenneth R. Todd.

John Hough Wickersham (1881–1960), president, John H. Wickersham Engineering and Construction Inc., Lancaster, Pa., died, July 26, 1960. Born, Lancaster, Oct. 11, 1881. Parents, J. Harold and Jessie W. (Hough) Wickersham. Education, graduate, Phillips Academy; BPh. Yale Univ., Sheffield Scientific School, 1901; CE. Married Marian S. Burrowes, 1911; children, Marianne B. and John H. A private practitioner in construction engineering for 58 years, except for two years in the U. S. Army, Mr. Wickersham started as a transitman with United Engineering and Contracting Co., and the New York City Rapid Transit Subway. In mid-1902 he became a laborer on the Hudson-Manhattan Tunnels, New York City, and six months later was superintendent of the construction. He was an inspector of the Connecticut River Bridge and Highway District, Hartford, Conn., in 1903, and six months thereafter went into business for himself as a civil engineer and contractor in Lancaster, Pa. He designed and constructed factory buildings, and accompanying mechanical equipment. From 1917 to early 1919 he was on active duty with the U. S. Army Corps of Engineers. He was commissioned a captain, was later a major, a lieutenant colonel, and then a colonel. He was decorated with the Purple Heart with Oak Leaf Cluster. He practiced engineering until his death. Mem. ASME, 1921. He also was a member of ASCE, ASHRAE, SAME, the Engineers Club of Philadelphia, and the Society of American Military Engineers. He was a director of the Farmers Bank and Trust Co., and a registered professional engineer in the State of Pennsylvania.


FLOOR
PLANS
LIST OF
EXHIBITORS
ASME
MEETING
HIGH LIGHTS
N. Y. COLISEUM
CENTRAL
PARK W
COLUMBUS CIRCLE
PARK W
NE WAY
NO
PARKI
NEW YORK
COLISEUM
PARKING
THE 24th
POWER AND
MECHANICAL ENGINEERING
SHOW
NOVEMBER 28 TO
DECEMBER 2
UNDER THE AUSPICES OF
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

A broad segment of the engineering community looks to the POWER SHOW to keep up with NEW DEVELOPMENTS

24th National Exposition of Power & Mechanical Engineering

HOURS

Mon., Nov. 28	12 Noon— 6 P.M.
Tues., Nov. 29	12 Noon— 6 P.M.
Wed., Nov. 30	12 Noon—10 P.M.
Thurs., Dec. 1	12 Noon— 6 P.M.
Fri., Dec. 2	12 Noon— 6 P.M.

Progress in engineering design will be revealed at the 24th National Exposition of Power and Mechanical Engineering by exhibits ranging from complete systems for serving public utilities, refineries, and other large plants to mechanical equipment for manufacturing establishments of every size and description. The biennial exposition at the New York Coliseum, November 28 to December 2, will also display the latest developments in raw and fabricated materials, component parts, motors, pumps, blowers and other mechanical equipment and a wide variety of controlling devices and instruments.

Of major interest at the Coliseum will be new aids to the economy of electric generating stations and even entire power systems. The new services extend from fully automatic control of machines and entire processes to electric accounting machines that produce graphic and tabular records of the vital information as fast as it develops.

New mechanical design will dominate the Exposition with outstanding developments to be shown in instruments, electronics, and materials. A more extensive application of plastics will be evident, while even more noteworthy progress will appear in the selection of rare and costly metals for specific purposes.

Illustrating current progress in the fabrication of the tougher metals, a display of parts centrifugally cast from various ferrous and nonferrous alloys will include extruded shapes from 1 to 8 in. in diam.

Piping. Another display will feature centrifugally cast, heavy-walled pressure piping for nuclear service, the first of its kind, authorized under a recent interpretation of the ASME Code for Pressure Piping.

There will be samples of high-temperature, high-pressure alloy and carbon-steel pipe, specially fabricated for electric generating stations.

Piping, fittings, and valves, along with meters, flow and level indicators, separators, traps, mixing valves, feeders, and other appliances, will constitute one of the most important displays of liquid and gas-moving equipment ever arrayed at a Power Show.

A new service will be offered for carrying out the intricate design of the extensive piping layouts that are interwoven for miles in many large facilities. The system brings into play a newly developed use for electronic computation.

Specialization in piping includes such remedial appliances for critical conditions as constant pipe supports, variable spring hangers, and sway braces, also an improved pipe-alignment guide, recently developed to prevent buckling of pipelines from thermal stress.

Further specialization will be reflected in a line of purifiers for removing liquid and solid entrainment from steam, air, and vapors in pipelines. Featured will be strainers and drainers for automatically freeing lines of condensate and other liquids.

Equipment for the installation and maintenance of piping will also be on view. For rolling tubes in boilers, condensers, and heat exchangers, one exhibitor will offer a torque-control instrument. Another has developed a device to stop the rotation of the tube expander at a predetermined torque, insuring uniformly tight joints, regardless of tube-hole variations.

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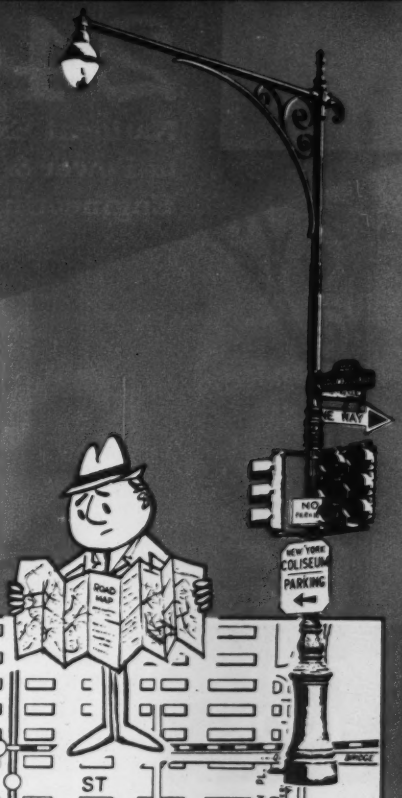
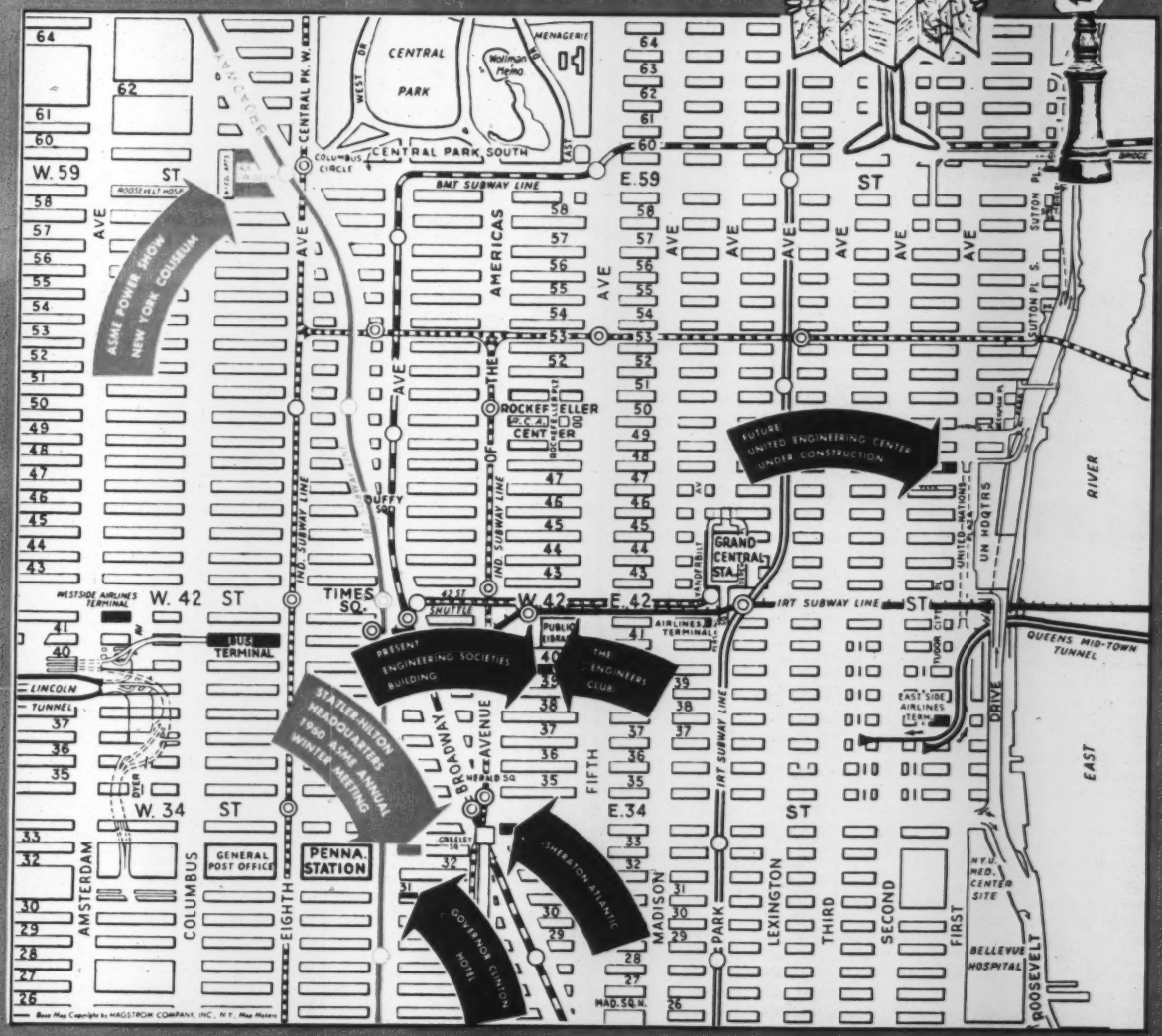
HOW TO GET TO THE N. Y. COLISEUM

AND OTHER PLACES OF INTEREST

Deep in the heart of Manhattan. The map highlights the important spots so that visitors may get around town easily—if there are no taxis available, check your map, there is a subway—The New York Coliseum where the Power Show will be held is five minutes by subway from the Statler Hilton Hotel where the Winter Annual Meeting will be held. The Engineer's Club and the present Engineers building is within walking distance, if you are meeting friends at the Club or planning to use the Engineering Societies Library. The Library should be high on everyone's list of "Places to Visit." Over toward the East River and diagonally across from the United Nations is the rapidly nearing completion United Engineering Center.





24th National Exposition of Power & Mechanical Engineering

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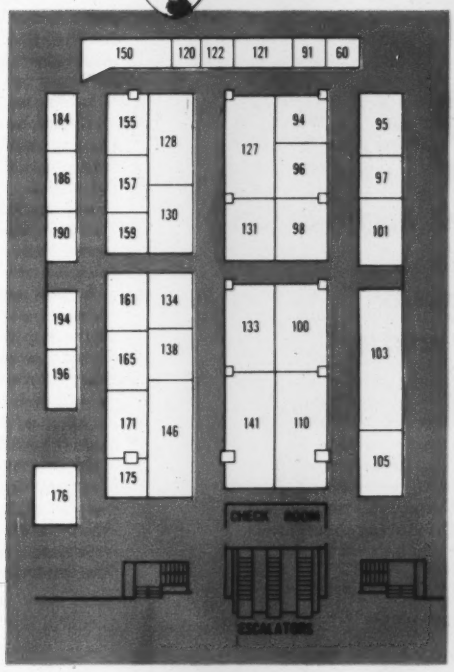
FLOOR PLANS



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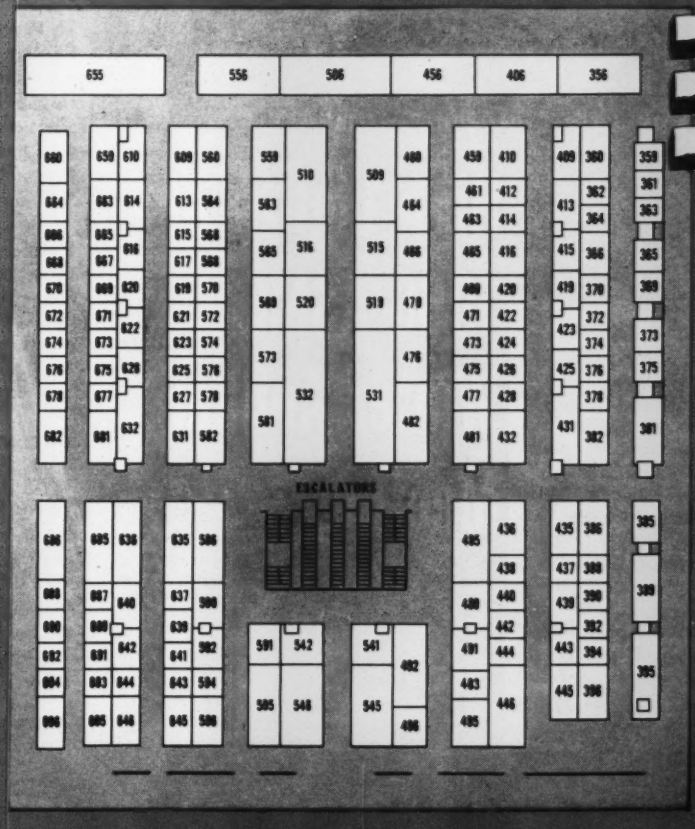
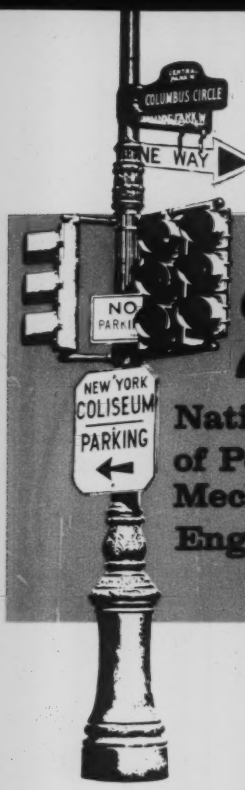




24th National Exposition of Power & Mechanical Engineering

UNDER THE AUSPICES OF
THE AMERICAN SOCIETY OF
MECHANICAL ENGINEERS
29 WEST 39th STREET
N.Y.C. 18, N.Y.

for the Power Engineer

High Lights of 1960 ASME Winter Annual Meeting

Orders for Technical Papers

ONLY numbered ASME papers in this program are available in separate copy form until Oct. 1, 1961. Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment also may be made by free coupons, or coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers. You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to: ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Continued from page 142

Further supporting the theme of liquid and gas transfer will be a great array of specialty valve operators, and controls. A characteristic development this year will be the increased employment of tough metals in otherwise standard designs. Special-purpose valves range from miniature-instrument and feeder valves of extreme accuracy to ponderous motorized pipe-line gates.

Instrumentation. Several exhibitors are equipped to furnish special types of equipment for an entire plant. One offers complete instrumentation including sensing devices, indicators, automatic controls, data-handling equipment, analyzing computers, and other instruments. A "performance monitor" will summarize over-all performance and indicate how operating economies may be improved.

A new annunciator system which would supplement any form of plant control has been devised to furnish visual and audible indication of any abnormal condition. The system will react to changes in pressure, temperature, high or low level, power or equipment failure, any break in an electric circuit, or even the opening of a circuit breaker.

Instruments on display will be noteworthy for their wider application and superior accuracy, especially in the field of process measurement. An electrolytic trace-gas analyzer will measure as low as 1 to 20 ppm of oxygen in other gases. The manufacturer of this instrument will also

▶TUESDAY, NOVEMBER 29

12:15 p.m. Fuels Luncheon

Presider: *William T. Reid*, assistant technical director, Battelle Memorial Institute, Columbus, Ohio

Speaker: *James H. Harlow*, chief mechanical engineer, Philadelphia Electric Company, Philadelphia, Pa.

Subject: **HEAT RATE ISN'T EVERYTHING**

12:15 p.m. Heat Transfer Luncheon

Presider: *Harold A. Johnson*, professor, department of mechanical engineering, University of California, Berkeley

Speaker: *Myron Tribus*, professor, engineering department, University of California, Los Angeles

Subject: **CONVECTION FROM NEWTON TO NOW**

▶WEDNESDAY, NOVEMBER 30

12:15 p.m. Management Luncheon and Towne Lecture

Presider: *Hugh A. Bogle*, supervisor, Industrial Engineering Activity, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del.

Lecturer: *L. Urwick*, Urwick House, London, England

Subject: **ENGINEERS IN MANAGEMENT – PAST AND FUTURE**

exhibit a stainless-steel regulator designed to prevent contamination of high-purity gases when it is necessary to measure total impurities of less than 10 ppm.

Complete industrial air service is another type of plant equipment that will be offered. This service includes over-all air conditioning, air-pollution control, air and gas handling, and the movement of dry materials by forced air.

Boilers and Boiler Controls. As in previous expositions, package boilers will be represented, including several completely automatic ones which will deliver a full head of steam in minutes from the touch of the starting button.

A brand new modulating boiler-sequencing and control system provides a fully automatic means of operating a bank of boilers so that only the number required to meet the load demand will be under high fire. Boilers are cut in and out of operation by predetermined pressure variations. Exhibited with this "master monitor" will be a new line of components including an air-flow regulator using adjustable characterized cams. The regulator may be used on boilers using two fuels by applying a "Duo-fuel" cam.

Mechanical Components. Mechanical components and manufacturing supplies will be exhibited in great variety. In several instances very large assortments of sizes and types are offered. An exhibitor of motorized worm-gear speed reducers will offer more than 900 combinations for delivery from stock in capacities from 1/6 to 5 hp and ratios from 5-to-1 to 60-to-1.

New this year will be a line of filled Teflon piston and rider rings. It will be exhibited in conjunction with a complete line of mechanical packings, gaskets, seals, Teflon gasketing, and expansion joints.

Unique among rust preventives for water systems will be a chemical additive that is odorless, tasteless, and non toxic. It is available in liquid form and also in crystals for use with an automatic feeder.

Special Displays. There will be many special displays at the Coliseum, including working models and demonstrations of welding and other techniques. Scale models of complete plants will also be on view. One will be a preview of a newly designed 360,000-kw closed-cycle nuclear reactor projected by a large utility on the Pacific Coast. When completed, it will be the largest unit of its kind.

Joseph Pope, Fellow ASME, is chairman of this year's advisory committee, which is composed of ASME representatives and engineers and executives representing a wide range of industrial interests.

E. K. Stevens, president of the International Exposition Company is manager of the Exposition. Headquarters of the management are permanently located at 480 Lexington Avenue, New York 17, N.Y.

PLANT TRIPS

▶TUESDAY, NOVEMBER 29

1:00 p.m. Indian Point Power Plant of Consolidated Edison Company of New York

1:30 p.m. Bayonne Research Laboratory of The International Nickel Company, Inc.

▶WEDNESDAY, NOVEMBER 30

9:00 a.m. New York International Airport, Idlewild, N. Y.

1:00 p.m. Model C Stellarator Laboratory at Princeton University

▶THURSDAY, DECEMBER 1

9:00 a.m. Grumman Aircraft Engineering Corporation, Bethpage, N. Y.

CORROSION AND DEPOSITS

THURSDAY, DECEMBER 1 9:30 a.m.

A Study of Sulfur Reactions in Furnace Deposits, by *Murray Weintraub, S. A. Goldberg,* and *A. A. Orning,* U. S. Bureau of Mines (Paper No. 60—WA-183)

Corrosion of Superheaters and Reheaters of Pulverized-Coal-Fired Boilers, Part 2, by *Carl Cain, Jr.,* and *Wharton Nelson,* Combustion Engrg., Inc. (Paper No. 60—WA-180)

Chemical Thermodynamics of Corrosion Products—Part 1: **Equilibrium Concentrations of Minor Constituents of Combustion Gas.** Part 2: **The Stabilities of Iron and Sodium Compounds in Fireside Deposits,** by *R. H. Boll* and *H. C. Patel,* The Babcock & Wilcox Co. (Paper No. 60—WA-182)

THURSDAY, DECEMBER 1 2:30 p.m.

Reactions of Magnesium With Inorganic Constituents of Heavy Fuel Oil and Characteristics of Compounds Formed,[1] by *W. D. Niles* and *H. R. Sanders,* Esso Res. & Engrg. Co.

[1] Paper not available

Slurry Spraying of Additives for the Control of Corrosion and Deposits in Oil-Fired Boilers,[1] by *W. F. Cantieri* and *R. E. Chappell,* Diamond Power Specialty Corp., and *R. A. Baker,* Public Service Elec. & Gas Co.

Effect of Ammonia Injection on Corrosion in Air Preheaters, by *Bernard Paris* and *Roy Kato,* Foster Wheeler Corp. (Paper No. 60—WA-255)

New Developments in Handling the Fuel-Oil Ash-Corrosion Problem, by *D. W. McDowell, Jr.,* and *J. R. Mihalisin,* International Nickel Co., Inc. (Paper No. 60—WA-260)

BOILER FEEDWATER STUDIES

FRIDAY, DECEMBER 2 9:30 a.m.

Evaluation of Steam Washers in Power-Plant Boilers, by *H. A. Klein,* Combustion Engrg., Inc. (Paper No. 60—WA-213)

Vacuum Deaerator Design, by *A. W. Kingsbury* and *E. L. Phillips,* The Permutit Co., Div. of Pfaudler Permutit Inc. (Paper No. 60—WA-214)

The Relation Between Boiler Cleanliness and Feedwater, by *F. U. Neat,* Baltimore Gas & Elec. Co. (Paper No. 60—WA-216)

Performance of Stainless - Steel Condenser Tubes, by *R. H. Pell,* Monongahela Power Co. (Paper No. 60—WA-217)

FRIDAY, DECEMBER 2 2:30 p.m.
Jointly With Power

German Developments in the Field of Acid Pickling of High-Pressure Boilers, by *H. G. Heitmann,* Siemens-Schuckertwerke A.G., Erlangen, Germany (Paper No. 60—WA-227)

New Chemical Cleaning Concepts and Possible Applications for the Future, by *C. M. Loucks,* consulting chemist, Westlake, Ohio (Paper No. 60—WA-259)

Chemical Cleaning of Pre-Boiler Equipment, by *W. B. Willsey,* Philadelphia Elec. Co. (Paper No. 60—WA-262)

Chemical Cleaning of Controlled Circulation Boilers, by *H. J. Vyhnalek,* Cleveland Elec. Illuminating Co. (Paper No. 60—WA-258)

Acid Cleaning of Superheaters and Reheaters, by *S. M. Rose* and *W. F. Ashton,* Sumco Engrg., Inc. (Paper No. 60—WA-219)

Chemical Cleaning With Citric Acid Solutions, by *W. E. Bell,* Chas. Pfizer & Co., Inc. (Paper No. 60—WA-257)

Precautions in the Use of Citric Acid, by *E. B. Morris,* American Elec. Power Service Corp. (Paper No. 60—WA-221)

FLUID METERS

MONDAY, NOVEMBER 28 2:30 p.m.

Expansion Coefficients for Orifice Meters in Pipes Less Than One Inch in Diameter, by *G. A. Marxman,* California Inst. of Tech., and *Henry Burlage, Jr.,* Case Inst. of Tech. (Paper No. 60—WA-137)

Gas-Tracer Method of Steady and Pulsating Flow Measurement, by *J. F. Kemp,* South African Council for Scientific & Industrial Research, Pretoria, Union of South Africa. (To be presented by *E. J. Lindahl,* Univ. of Wyoming.) (Paper No. 60—WA-142)

Flow Measurement for Accounting Purposes, by *D. D. Livingstone,* Polymer Corp. Ltd., Sarnia, Ont., Canada (Paper No. 60—WA-141)

FUELS

MONDAY, NOVEMBER 28 9:30 a.m.
Special Fuel Applications

Coking Stokers,[1] by *Walter Giesing,* Central Fibre Products, and *John Cruise,* consultant

Fuels in the Cement Industry,[1] by *F. B. Tripp,* Portland Cement Assoc.

Tangential Firing of Regenerator-Waste Gas in CO Boilers,[1] by *Joseph Singer* and *S. Blackburn,* Combustion Engrg., Inc.

MONDAY, NOVEMBER 28 2:30 p.m.
Jointly With Power
Panel Discussion: Furnace Safeguards

for the Power Engineer

High Lights of 1960 ASME Winter Annual Meeting

TUESDAY, NOVEMBER 29 9:30 a.m.

Experiments on an MHD Fuel-Burning Generator,[1] by *W. E. Young*, Westinghouse Res. Labs.

Studies of Heat Absorption With Pulverized-Coal Firing,[1] speaker to be announced.

TUESDAY, NOVEMBER 29 2:30 p.m.

The Measured Effects of Some Operating Conditions on Fouling Tendencies of Low-Temperature Boiler-Flue Gases,[1] by *A. W. Black*, Air Preheater Corp.

Effects of Combustion Conditions on Nitrogen Oxide Formation in Boiler Furnaces,[1] by *J. D. Sensenbaugh* and *J. Jonakin*, Combustion Engrg., Inc.

HEAT TRANSFER

TUESDAY, NOVEMBER 29 2:30 p.m.

Convective Processes, Solid State, Multiphase Processes

Turbulent Heat Transfer in Stratified Flow,[1] by *F. Schultz-Grunow*, Lehrstuhl für Mechanik, Technische Hochschule, Aachen, Germany

Transport of Thermal Energy in Solids,[1] by *J. A. Krumhansl*, Cornell Univ.

Things We Don't Know About Boiling Heat Transfer,[1] by *J. W. Westwater*, Univ. of Illinois

TUESDAY, NOVEMBER 29 8:00 p.m.

Radiation Processes

Recent Studies on Quantitative Spectroscopy and Gas Emissivities[1], by *S. S. Penner*, California Inst. of Tech., *D. B. Olfe*, and *M. Lapp*

Gaseous Radiation With Temperature Gradients, by *H. C. Hottel*, M.I.T.

Thermal Radiation Characteristics of Surfaces,[1] by *R. V. Dunkle*, Commonwealth Scientific & Industrial Res. Organization, Victoria, Australia

THURSDAY, DECEMBER 1 2:30 p.m.

Change of Phase

A Correlation of Local Pressure Gradients for Subcooled Boiling of Water in Vertical Tubes, by *W. L. Owens, Jr.*, Univ. of Aberdeen, Aberdeen, Scotland, and *V. E. Schrock*, Univ. of California (Paper No. 60—WA-249)

Film-Boiling Heat Transfer From a Horizontal Surface, by *P. J. Berenson*, M.I.T. (Paper No. 60—WA-147)

INSTRUMENTS AND REGULATORS

THURSDAY, DECEMBER 1 9:30 a.m.

The Measurement of High-Frequency Pressure Fluctuations Between Impeller Blades in an Operating Gas-Turbine Compressor,[1] by *Peter Stein*, Arizona State Univ.

Stress Analysis of a Radial Flow Rotor, by *M. J. Schilhansl*, consulting engr., Cranston, R. I. (Paper No. 60—WA-200)

Frequency-Response Analysis of a Hydraulic Servomechanism With Several Nonlinearities, by *J. Van deVegte*, Univ. of Toronto, Toronto, Ont. Canada (Paper No. 60—WA-45)

Transfer Function Derivation and Verification for a Toric Variable Speed Drive,[2] by *J. L. Harned, P. Sudhindranath, K. M. Miller*, and *R. J. Roddy*, Gen. Motors Tech. Center (Paper No. 60—WA-184)

THURSDAY, DECEMBER 1 2:30 p.m.

Dynamic Characteristics of Some Valve-Actuator Hydraulic Controls, by *V. C. Tsien*, Cleveland Pneumatic Tool Co. (Paper No. 60—WA-54)

Dynamic Behavior of a Simple Pneumatic Pressure Reducer, by *D. H. Tsai* and *E. C. Cassidy*, Nat. Bureau of Stds. (Paper No. 60—WA-186)

Identification of Process Parameters by Means of Learning Models, by *Herman Thal-Larsen* and *Y. Takahashi*, Univ. of California (Paper No. 60—WA-121)

Bibliography on Diaphragms and Bellows,[2] by *L. M. Van der Pyl*, Rockwell Mfg. Co. (Paper No. 60—WA-122)

FRIDAY, DECEMBER 2 9:30 a.m.

Mixing Studies in a Shell and Tube Heat Exchanger, by *G. C. Vincent*, Monsanto Chemical Co. (Paper No. 60—WA-261)

On the Dynamics of Steam/Liquid Heat Exchangers, by *Arvid Hempel*, Chr. Michelsen Inst., Bergen, Norway (Paper No. 60—WA-110)

Dynamic Response of Heat Exchangers Having Internal-Heat Sources—Part 4, by *Wen-Jei Yang*, Mitsui Engrg. & Shipbuilding Co., Tamano, Okayama, Japan, *J. A. Clark*, and *V. S. Arpaci*, Univ. of Michigan (Paper No. 60—WA-127)

NUCLEAR ENGINEERING

MONDAY, NOVEMBER 28 9:30 a.m.

Panel Discussion: Some Methods of Direct Conversion of Energy

Thermionic Converters,[2] by *R. W. Pidd*, Gen. Atomic, Div. of Gen. Dynamics Corp.

Thermoelectric Power Generation,[2] by *F. H. Horn*, Gen. Elec. Res. Lab.

Fuel Cells,[2] *speaker to be announced*

Magnetohydrodynamics,[2] by *Stewart Way*, Westinghouse Elec. Corp.

MONDAY, NOVEMBER 28 2:30 p.m.

Panel Discussion: Design and Status Reports on Large Power Reactors

The Status of the Dresden Nuclear Power Station,[2] by *H. K. Hoyt*, Commonwealth Edison Co.

Yankee Atomic Electric Plant,[2] by *G. A. Reed*, Yankee Atomic Elec. Co.

Status Report of the Enrico Fermi Atomic Power Plant,[2] by *C. H. Clark*, The Detroit Edison Co.; Power Reactor Dev. Co.

Indian Point Station,[2] by *R. H. Freyberg*, Consolidated Edison Co. of N. Y.

TUESDAY, NOVEMBER 29 9:30 a.m.

Design and Status Report of the Experimental Breeder Reactor II[2], by *L. J. Koch*, Agonne Nat. Lab.

The Design and Status of the Reactor and Pilot Plant for the Plutonium Recycle Program, by *R. M. Fryar*, Gen. Elec. Co. (Paper No. 60—WA-225)

Economics of Spectral Shift Control,[2] by *R. W. Deuster* and *Zelvin Levine*, The Babcock & Wilcox Co.

TUESDAY, NOVEMBER 29 8:00 p.m.

A Binary Vapor Nuclear Power Plant,[1] by *J. K. Salisbury*, consulting engr., Atherton, Calif., and *D. R. Sawle*, Aerojet Gen. Nucleonics

Steady-State Fluid Fow in a Closed Loop With Two Parallel Channels,[1] by *T. R. Bump*, Argonne Nat. Lab.

Transient Thermal Stresses in Tubular Reactor Fuel Elements, by *L. I. Deverall*, Univ. of California (Paper No. 60—WA-248)

POWER

WEDNESDAY, NOVEMBER 30 9:30 a.m.

Test-Boiler Facility for Testing the Main Propulsion Machinery and Auxiliary Equipment of Nuclear Powered Ships and Submarines, by *F. J. Myers*, Newport News Shipbuilding & Dry Dock Co. (Paper No. 60—WA-146)

Vessel-Component Performance Since World War II, by *E. S. Shulters* and *F. H. Van Riper*, Office of Ship Construction, U. S. Dept. of Commerce (Paper No. 60—WA-132)

Ventilation of Eddystone Station—An Approach to Ventilation of Modern Steam-Electric Generating Stations, by *S. J. Kowalski*, Philadelphia Elec. Co. (Paper No. 60—WA-44)

Optimizing a Regenerative Steam-Turbine Cycle, by *G. Chiantore, D. Borgese*, and *F. Baldo*, Edisonvolta, Milano, Italy, and *J. H. Potter*, Stevens Inst. of Tech. (Paper No. 60—WA-179)

WEDNESDAY, NOVEMBER 30 2:30 p.m.

A Simplified Analysis of the No Load Stability of Mechanical-Hydraulic Speed-Control Systems for Steam Turbines, by *M. A. Eggenberger*, Gen. Elec. Co. (Paper No. 60—WA-34)

Economic Generation Planning Using a Digital Computer, by *W. J. Fahrner* and *C. M. Heidel*, Detroit Edison Co. (Paper No. 60—WA-156)

Does Condensing Water Affect the River? by *M. D. Engle*, Pennsylvania Power & Light Co. (Paper No. 60—WA-92)

THURSDAY, DECEMBER 1 9:30 a.m.

Economy of Efficient Air Preheating With Extraction Steam, by *M. K. Drewry*, Wisconsin Elec. Power Co. (Paper No. 60—WA-94)

Methods for Measuring Steam-Turbine-Generator Performance, by *K. C. Cotton* and *J. C. Westcott*, Gen. Elec. Co. (Paper No. 60—WA-139)

Transient Loading Improvements for Large Steam-Electric-Generating Units, by *Charles Strohmeyer, Jr.*, Gilbert Associates, Inc. (Paper No. 60—WA-51)

THURSDAY, DECEMBER 1 2:30 p.m.

Methods of Obtaining Accurate Boiler-Water Level Indication, by *J. W. Williams*, Yarnall-Waring Co. (Paper No. 60—WA-74)

Power-Plant Performance Monitoring, by *J. K. Salisbury*, consulting engr., Atherton, Calif. (Paper No. 60—WA-222)

The Application of the Deviation Concept of Turbine-Cycle Monitoring,[1] by *H. T. Hoffman*, Bailey Meter Co., and *C. P. Welch*, The Babcock & Wilcox Co.

POWER TEST CODES

MONDAY, NOVEMBER 28 9:30 a.m.

The Effects of Measurement Errors on the Calculation of Steam-Generator Efficiency,[1] by *J. H. Born, Jr.*, Foster Wheeler Corp.

Efficiency Determination of Marine Boilers—Input-Output Versus Heat-Loss Method,[1] by *Leonard Cohen* and *W. A. Fritz, Jr.*, U. S. Naval Boiler & Turbine Lab.

MONDAY, NOVEMBER 28 2:30 p.m.

A Generalized Approach to One-Dimensional Gas Dynamics,[1] by *R. P. Benedict* and *W. G. Steltz*, Westinghouse Elec. Corp.

Some Generalizations in One-Dimensional Constant Density Fluid Dynamics,[1] by *W. G. Steltz* and *R. P. Benedict*, Westinghouse Elec. Corp.

Polytropic Analysis of Centrifugal Compressors,[1] by *J. M. Schultz*, Borg-Warner Corp.

[1] Paper not available

YARWAY **Y** *news briefs*

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD

WHY YARWAY WELBONDS ARE SPECIFIED FOR HIGH PRESSURE VALVE JOBS

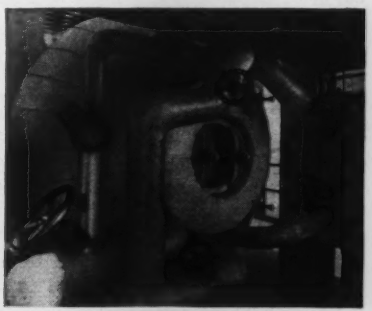
Yarway Welbond Valves (sizes ¼" through 2½") have won resounding acceptance from boiler room operators everywhere because of these 6 unique features—resulting in *outstanding performance* that is *dependable* and *trouble-free:*

1. Full accessibility—all working parts readily removed through top of yoke. Jack action of stem forces out old packing.
2. Guided valve stem of #321 stainless steel—will not "pit." Self-aligning, stellite-faced disc.
3. High temperature inhibited stem packing furnishes double insurance against packing leaks.
4. Unique seat design with thermal compensating groove that prevents distortion during assembly welding and when welding valve into line. Also permits perfect seating of disc for tight seal. Integral seat is stellite-faced.
5. One-piece forged chrome-moly steel body and yoke.
6. Easy-grip, ventilated handwheel—makes operating a "breeze".

More details—and list of users? Write Yarway. Ask for Bulletin B-454.

Four of many Yarway Welbonds installed in large eastern public utility plant. Steam pressure 1850 psi; temperature 1000°F.

Four Yarway Welbonds on main steam line to turbine at southern power plant. Press. 2310 psi; temp. 1000°F. Over 100 Welbonds here.



Six of 900 Yarway Welbonds at southwest utility. Boiler drum pressure in this plant—2150 psi; superheat temperature 1005°F.

JENKINS PRACTICAL PIPING LAYOUT 83

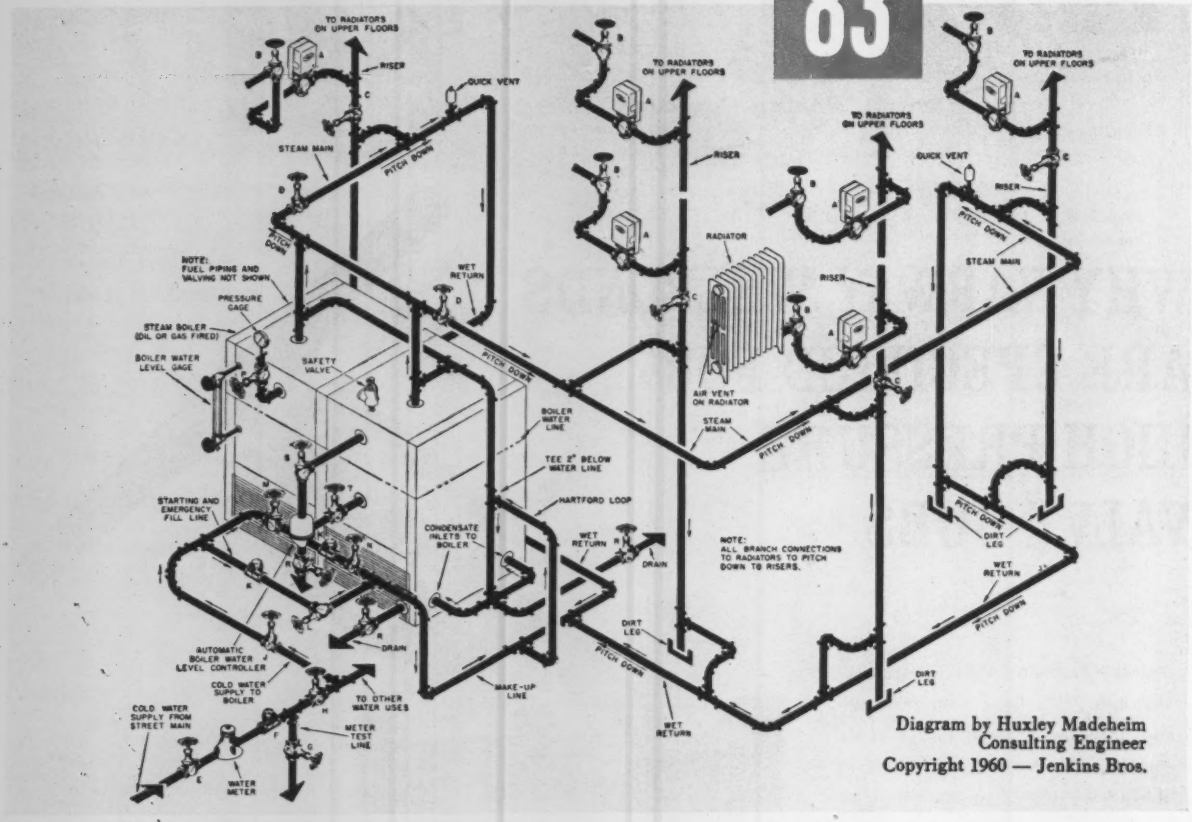


Diagram by Huxley Madeheim
Consulting Engineer
Copyright 1960 — Jenkins Bros.

ONE-PIPE HEATING SYSTEM WITH INDIVIDUAL THERMOSTATIC CONTROL OF EACH AREA

Because of low installation, operation and maintenance costs, this one-pipe system is popular for multi-story buildings where radiators are placed one above the other in line on various floors. It requires no traps, pumps, expansion or balance tanks or special fittings, and its simplicity avoids danger of freeze-up or water leaks. Thermostatic control of the fuel burner and elimination of dependence upon manually-controlled radiators remove principal objections to the conventional one-pipe system . . . the time delay in starting from a cold boiler, uneven heating due to this delay, and insufficient pressure to assure steam in furthermost radiators.

The burner in the boiler of this system operates responsive to an outdoor thermostat which starts or cuts off the burner whenever outside temperature changes from a predetermined value. The burner is also controlled by a pressurestat which cuts off burner at a predetermined value such as 8 psi, and starts it at a lower limit such as 4 psi. The burner can also be controlled by a program clock.

Each individual radiator or area is controlled by a motor operated globe valve of the type made by New England Gear Works, Southington, Connecticut. Each of the valves opens or closes responsive to a thermostat located in the area served by the radiator. The combination of outdoor and area thermostats assures steam in the system and even heat at all times in all areas. A manually-operated radiator angle valve permits shut-off of each radiator whenever desired. A gate valve at bottom of each riser allows access to motor operated valves on that line.

Conventional steam boiler piping and controls are used, with an automatic boiler water level controller, fitted with a manually operated by-pass.

Jenkins Fig. 47-U Standard Bronze Gate Valve, in this layout has design features which assure excellent performance in steam heating service. A solid bronze wedge affords maximum resistance to pressure strains of rapidly vibrating steam. A rising spindle and wheel indicates wedge position, and the backseating bevel on shoulder of spindle permits the valve to be repacked under pressure when wide open.

To assure efficiency in the job when planning any major piping installation, consult with accredited piping engineers and contractors, and select your valves from the Jenkins Catalog.

Enlarged diagram and full description of this layout No. 83 free on request to Jenkins Bros., 100 Park Avenue, New York 17.

CODE	QUAN.	VALVES RECOMMENDED	SERVICE
A	6	Motor Operated Globe made by New England Gear Works	Automatic Steam Control
B	6*	Fig. 168, Bronze Radiator Angle	Manual Control Steam to Radiators
C	4**	Fig. 47-U, Bronze Gate	Individual Riser Shutoff
D	2	Fig. 47-U, Bronze Gate	Boiler Mains Shutoff
E	1	Fig. 47-U, Bronze Gate	City Water Supply Shutoff
F	1	Fig. 92-A, Bronze Swing Check	Prevent Backflow into City Water Main
G	1	Fig. 106-A, Bronze Globe	Meter Test Flow Control
H	1	Fig. 47-U, Bronze Gate	Building from Meter Shutoff
J	1	Fig. 47-U, Bronze Gate	City Water Make-up to Boiler Shutoff
K	2	Fig. 92-A, Bronze Check	Prevent Backflow from Boiler to City Water
L	1	Fig. 108-A, Bronze Angle	Manual Control Water to Boiler
M	1	Fig. 106-A, Bronze Globe	Control Automatic Boiler Water Level Controller
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P	1	Fig. 743-G, Bronze Needle	Steam to Pressure Gage Control
R	3	Fig. 108-A, Bronze Angle	Control Drainage from Boiler and Equipment
S	1	Fig. 108-A, Bronze Angle	Shutoff Automatic Boiler Water Level Controller from Boiler
T	1	Fig. 106-A, Bronze Globe	Shutoff Automatic Boiler Water Level Controller from Boiler

*One for each Radiator **One for each Riser

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FOR convenience in locating catalogs about particular equipment, product or service, a list is given below in which the numbers refer to the catalog items beginning on page 153. This will aid you in locating something specific although a perusal of the entire list may disclose other items of more than usual interest to you.

This November 1960 insertion of NEW CATALOGS Guide replaces the regular "Keep Informed" Section for this issue. The "Keep Informed" Section will appear regularly again beginning with the next issue.

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1 BALL BUSHINGS

The Torrington Co., Bantam Bearings Div.—Catalog 960 presents line of self-aligning ball bushings, Series SBB for industrial applications and Series ASBB for aircraft applications. Bore diameters range from 0.5000 in. to 6.0000 in. Bushings are designed to accommodate misalignment while supporting radial, thrust, or combined loads.

2 ECCENTRIC PLUG VALVE

W-K-M Div. of ACF Industries, Inc.—W-K-M's new eccentric type plug valves are described in Bulletin AE 1059. They feature elastomer coated plug for tight sealing, and are nonlubricated, wrench or gear operated with maximum flow, quarter-turn open or close. Sizes 1/2 in. through 12 in., 150 lb cwp.

3 LARGE-CAPACITY STORAGE TANK

Graver Tank & Mfg. Co.—Bulletin describes the Graver Cylindroid, a new design for a steel storage tank of claimed unlimited capacities and dimensions. Engineered and tested in a full-scale tank, this new design is square or rectangular in plan, and is said to be well-suited to situations where ground space is limited and must be fully utilized for bulk storage.

4 ENGINE AND PROCESS CONTROLS

Amot Controls Corp.—Bulletin 306 describes the various types of thermostatic valves, safety and function controls for hydraulic and pneumatic systems. Bulletin 525 illustrates the new Model 2800 safety control for small engines and compressors.

5 SCREW PUMPS

Warren Pumps, Inc.—Bulletin No. 255 features twin screw pumps for oils and other noncorrosive liquids for wide viscosity range at discharge pressures up to 350 psig and capacities up to 550 gpm. Selection nomograph, outline dimensions, sectional drawings, and details of design and construction are provided.

6 RAM-TYPE STOKER INSTRUCTIONS

Bituminous Coal Institute—Folder gives concise, illustrated instructions for operation of ram-type underfeed stokers with dump grates. Information covers starting fire, cleaning fire and restoring fuel bed, and common trouble-shooting. It is printed on heavy paper in two colors and punched for hanging near firing unit.

7 MECHANICAL POWER TRANSMISSION

Worthington Corp.—Eight-page catalog lists various mechanical power transmission and variable speed drive products. Bulletin 7900-B2 includes descriptions of all products and references for additional information regarding selection and application.

8 REVERSE FLOW CONDENSERS

C. H. Wheeler Mfg. Co.—Eight-page catalog describes the advantages of "self-cleaning" reverse flow steam condensers. Diagrams show how the principle works in both divided and non-divided water box condensers. Typical vacuum record charts are included.

9 COPPER CHARACTERISTICS

Anaconda American Brass Co.—Publication B32 provides tables listing some of the properties of standard Anaconda copper and copper alloys. Included are compositions, forms available, certain physical properties, fatigue strength, creep strength, welding rods.

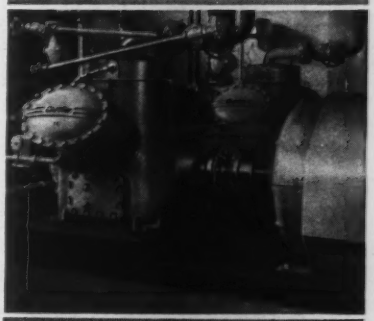
10 FLUID POWER EQUIPMENT

Oilgear Co.—Bulletin 10051-J covers variable delivery, constant delivery, and automatic feed pumps; constant and variable speed transmissions; constant and variable displacement motors; fluid power cylinders; servo components; directional, relief, foot, and surge valves; additional valves and accessories.

11 REFRIGERATION EQUIPMENT

York Corp.—Bulletin EM60-2235 describes the compact hermetic Turbopak for various water chilling applications with system applications, including air conditioning.

HOLDING PEAK PERFORMANCE in Power Transmission



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- Free End Float
- Smooth Continuous Drive with Constant Rotational Velocity
- Visual Inspection while in Operation
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- Unaffected by High or Low Temperatures
- No Lubrication
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- No Maintenance

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WARREN, PENNSYLVANIA, U.S.A.

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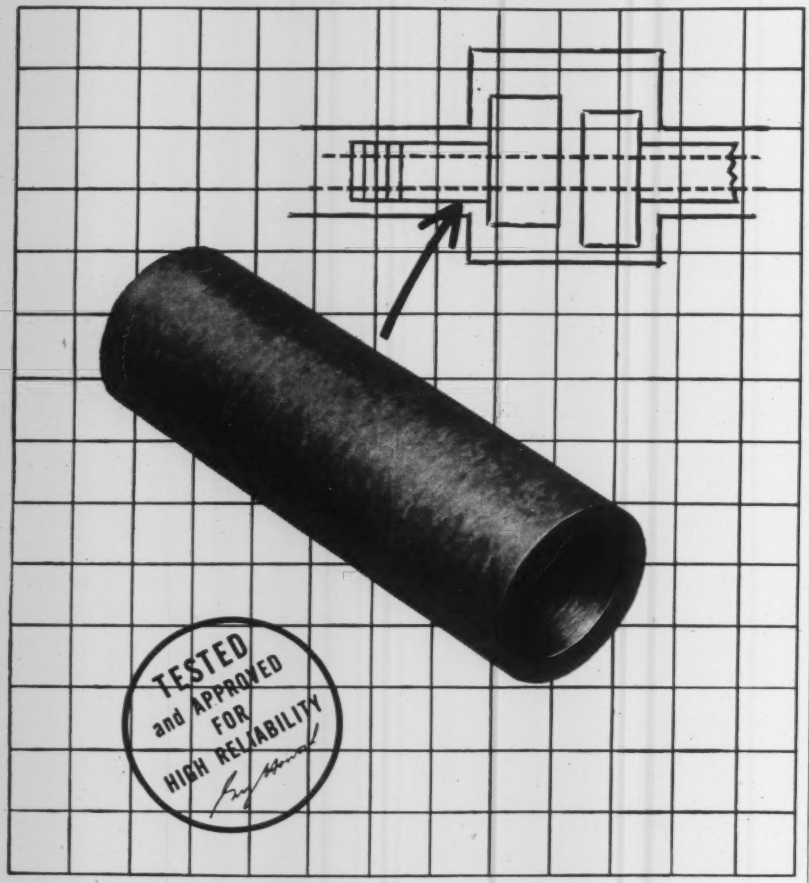
• to resist corrosion • to eliminate contaminating lubricants



R/M reinforced Teflon bearings are giving excellent service in a wide variety of industries. In the chemical industry, their use has greatly extended the range of chemicals that can be handled by a single pump — and lengthened the life of shafts in acid pumps. In the textile and food industries, they have eliminated the need for lubricants and the resulting contamination of materials in process. And in almost every application, they have lowered replacement costs and maintenance requirements while reducing wear.

R/M reinforced Teflon bearings can be machined to very close tolerance. The high rate of thermal expansion and poor cold flow characteristics of pure "Teflon" have been greatly reduced with this reinforced material.

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*Registered trademark for Du Pont fluorocarbon resins

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RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N. J.
MECHANICAL PACKINGS AND GASKET MATERIALS

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12 CONTROL VALVES

A. W. Cash Co.—Eight-page general sales Bulletin S.C.R.-1 describes the firm's self-contained regulating and relief valves, temperature and pilot operated valves, combustion controls, and split body control valves. Also the 6000 series control valves built in sizes from 1/2 in. through 16 in.

13 PACKAGED BOILERS

Western Boiler Co.—Catalogs give specifications and capacities for Webco-Ray automatic forced draft packaged boilers, Husky and FD series. Sizes range from 10 to 600 h.p. Units for operation on all grades of fuel oil, natural or manufactured gas, or combination gas-oil. Tables and other technical data included.

14 EXPANSION JOINTS

Zallea Brothers—A 72-page catalog contains technical data, illustrations and information covering the company's eleven basic types of expansion joints. Tables, charts, and drawings give engineering specifications. Selection chart tells how to choose the correct expansion joint.

15 PUMPS

Jabsco Pump Co.—The 1960 catalog presents data on pumps for marine, chemical, plumbing, industrial, farm and bottling applications. Features, installation drawing, exploded view, and parts list are provided for each model. A table gives chemical resistance of different valve materials towards different substances.

16 FIBER GLASS INSULATION

Johns-Manville—Illustrated brochures outline advantages of Microlite, Microtex, Micro-Lok and Micro-Bar fiber glass insulations, low-density resilient insulating materials with high thermal efficiency and sound absorption characteristics. They are described as being light in weight, resistant to heat, fire, moisture, and corrosion and the company recommends their use in applications where the greatest thermal and acoustical efficiency is desirable in the smallest space. Tables are included on thermal and acoustical performance.

17 RADIAL ENGINES

Nordberg Mfg. Co.—A 16-page bulletin describes radial engines, two-cycle diesel, spark-ignition gas, and Duafuel. The bulletin, No. 200A, describes recent engineering and design features which include supercharging of the spark ignition radial engines for an increase in rating of approximately 50 per cent over normally scavenged engines.

18 SCREW CONVEYERS

Link-Belt Co.—Applications and selection of screw conveyers, screw feeders, and components are the subjects of 76-page Book 2989. It illustrates over 20 different types of screws, 14 types of troughs, with four types of covers, five types of discharge openings, and two types of feeders.

19 GAS-TURBINE-DRIVEN COMPRESSOR

Solar Aircraft Co.—A line of centrifugal gas compressors, developed for use with gas-turbine engines, is described in a four-page bulletin. Included are cross-section views, dimensional drawings and performance data.

20 HEAT EXCHANGER TUBING

Babcock & Wilcox Co., Tubular Products Div.—An eight-page brochure, TB431, introduces "Lectrosonic" heat exchanger tubing. It details manufacturing and testing procedure, and points out features.

21 BUTTERFLY VALVE

Henry Pratt Co.—Catalog No. 10Z illustrates and describes a new type of flangeless rubber seat butterfly valve. Included are dimensions of all sizes, instructions for choosing proper size, operators, and material combinations, water and air flow data and price sheets.

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22 SPREADER STOKERS

Erie City Iron Wks.—Catalog SB62 describes dumping grate spreader and the Travagrate (continuous ash discharge) spreader stokers. Coal feed and control for both types are illustrated. The hydraulic Travagrate drive unit is shown in phantom view. Typical applications are included.

23 CONVEYER BELTING

Manhattan Rubber Div., Raybestos-Manhattan Inc.—A 12-page brochure, No. M302, covers new conveyer belting. Drawings are used to describe the compensation and other features. Pages are arranged to represent an actual cross-section of the belt. It is claimed no breaker fabric is required with this belt, which means more thickness of the cover is utilized.

24 REFINERY PUMPS

Dean Brothers Pumps Inc.—Circular 201 describes new line of heavy duty centrifugal pumps for refinery and process service with top suction and discharge nozzles. Built to API and major oil company specifications, the units have capacities up to 1000 gmp. Pump sizes, mechanical design specifications, sectional view with parts list.

25 VACUUM JACKETED PIPING

Uni-Flex Mfg. & Engineering, Inc.—Four-page brochure on multi-jacketed piping provides the engineer with a sample specification for cryogenic piping and a table of conversions between Kelvin, centigrade, Fahrenheit, and Rankine scales.

26 LOW TEMPERATURE REFRIGERATION

Niagara Blower Co.—Bulletins 95 and 105 describe "No-Frost" method of refrigeration producing and holding temperatures of O F and below, completely automatic in operation continuously without defrosting shutdown even under high moisture load. Applications are subzero testing, controlled atmospheres, food freezing and warehousing, meat packing, orchard or field crop pre-cooling and storage.

27 COAL-FIRED PACKAGED BOILER

Foster-Wheeler Corp.—Coal-fired packaged steam generators are offered in three standard sizes: 43,000, 50,000, and 63,000 lb per hr, 250 psi. They are said to be easily converted to oil firing. Bulletin PG 59-4 details components, construction, and performance of the unit.

28 BEARINGS AND BARS

Bunting Brass & Bronze Co.—Catalog 158 covers standard stock cast bronze bearings and bars, sintered powdered oil-filled bearings and bars, and aluminum bar stock bearing material. Catalog 32 describes nylon rod, tubes, and plates. Catalog 258 includes stock sizes of electric motor bearings.

29 STEAM TRAPS

Sarco Co.—Condensed Catalog contains 12 pages of technical details, dimensions, and capacity data on the line of steam traps, temperature regulators, and heating specialties.

30 WELL WATER SYSTEMS

Layne & Bowler, Inc.—Bulletin No. 100 gives general facts and information on well water systems, pumps, drilling and allied services and equipment. The bulletin covers water well systems, oil and water lubricated vertical turbine pumps, special water well drilling, service work, shutter screens, irrigation wells and pumps, water and well treatment for rehabilitating water sources and other phases of water development for industry and municipalities.

31 FRESH AIR SUPPLY HEATERS

L. J. Wing Mfg. Co., Div. of Aero Supply Mfg. Co.—Bulletin GFAS-60 describes Wing direct-gas-fired fresh-air-supply heaters of unitized construction, factory pre-wired and piped ready for installation. They are made in five sizes suited for wall or roof inlet and offer up to 50,000 cfm and 4,500,000 Btu per hr output.

32 ROLLER CHAIN

Acme Chain Corp.—Catalog No. 7 covers dimensions, list prices, engineering data, design suggestions for roller chain, double pitch chain attachments, cable chain, AL series and BL series, stainless steel chains, chain couplings, conveyer chains, bakery chains, and radius chains.

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Koppers coupling service cuts costly down-time

Not every coupling service need is an emergency. But it's the emergencies that really test a good organization. That's why Koppers maintains experienced field engineers and outstanding stock facilities throughout the country. In addition, if it's a Fast's Coupling you're replacing, we have a serial number and specific application history for every Fast's for easy reordering. And our modern manufacturing facilities have the extra capacity to lick an emergency for special requirements.

Example: A modern windowless bank in Georgia was able to open for business as usual only because Koppers flew in a completed replacement coupling for its air conditioning unit. Elapsed time . . . request phoned to Baltimore after 10 in the evening . . . coupling arrived before 7:30 next morning.

KOPPERS COMPANY, INC., 511 Scott St., Baltimore 3, Md.

KOPPERS

FAST'S COUPLINGS

Engineered Products Sold with Service

33 LARGE DATA PROCESSING SYSTEMS

Minneapolis-Honeywell Regulator Co.—Booklet describes features and capabilities of the Honeywell 800, a large-scale data processing system. High-speed peripheral equipment can be multiplexed for data processing applications, and the availability of floating-point arithmetic and the ability to work in binary is said to make the system adept at scientific computation.

34 PLASTIC SHAPES

Garlock Inc.—A 16-page bulletin, AD-177, titled "Plastic Stock Shapes, Molded and Fabricated Parts" has been issued. Included are units manufactured from Teflon, Polychlorotrifluoroethylene (CTFE), Delrin, Nylon, and other resins in form of sheets, tapes, rods, tubes, bars, cylinders, etc.

35 WATER TUBE BOILERS

Henry Vogt Machine Co.—A 24-page bulletin describes Class VF and Class VS 2-drum bent tube boilers. Photos and line drawings illustrate typical units as installed in industry.

36 PIPING ERECTION, FABRICATION

Midwest Piping Co.—A 24-page "Power and Process Piping" brochure demonstrates the experience and capability Midwest has in erecting and fabricating piping of all kinds for electric utilities, industrial and process plants.

37 SPEED REDUCERS

Link-Belt Co.—"Worm Gear Speed Reducers," Book 2824, is a 66-page publication that introduces line of fan-cooled worm gear speed reducers in 25 types and over 135 sizes. They are available in ratios ranging from 5:1 to 3600:1, with torque ratings up to 135,000 lb-in. and horsepower ratings up to 150. The new book is illustrated with many application photos and lists equipment on which these reducers are frequently used.

38 BELLOWS EXPANSION JOINTS

Tube Turns—Bulletin TT943 explains new rating concept based on minimum assured cyclic life predicated on empirical evaluation of the interrelation between traverse, pressure, and cyclic behavior. It also gives dimensional data and rating tables for reinforced and unreinforced bellows expansion joints, sizes 3 through 30 in., 75 and 400 psi.

39 STEAM AND WATER SERVICE

The Powers Regulator Co.—Specially prepared for plant use, the manual is designed for personnel whose job function covers operation or installation of steam-water service. Various control systems described and illustrated include: domestic hot water, instantaneous heat exchangers, heat exchangers for cooling, fuel oil heaters, pressure reducing, jacket water cooling, and two-temperature hot water systems.

40 ROTARY PUMPS

Viking Pump Co.—Eight-page Catalog 60S includes illustrations and specifications on general purpose and heavy-duty rotary pumps. Capacities range from 1/2 to 1050 gpm, pressures up to 200 psi on heavy-duty models.

41 CENTRAL STATION AIR CONDITIONING UNIT

American Air Filter Co.—Bulletin AC-100 introduces a new line of Kennard/Nelson central station air conditioning units. It is possible to select complete packaged units with coils, accessories, filters, even traps without referring to separate bulletins.

42 CHAINS, SPROCKETS

Diamond Chain Co.—Catalog No. 760 covers the firm's standard products and gives specific engineering data on chain selection, horse power ratings, chain and sprocket recommendation sizes.

43 VIBRATING SEPARATORS

Southwestern Engrg. Co.—Catalog describing 18, 30, and 48 in. vibro-energy separators. It presents operating, application, and specification data on screening all types of dry materials and separation of solids from liquids in your industry.

44 DEAERATION

Cochrane Corp.—Publication No. 4650 explains in capsule form the fundamentals of deaeration and why it is necessary in water conditioning. The principles of operation as well as the advantages and application of the various methods of deaeration are discussed.

The pump that fills the "Vital Gap" NEW MIXED-FLOW BY JOHNSTON

Large capacities at medium lifts

This new Johnston fills the "vital gap" between low head—large capacity propeller pumps and high head—smaller capacity regular turbines.

Thoroughly field-tested and already enthusiastically recommended by a score of satisfied users, it is now available for a wide range of applications and is the latest addition to the Johnston line of versatile vertical pumps.

Design Features:

- Capacities exceeding 100,000 gpm.
- Lifts from 20 to 60 feet.
- Flatter hp curve means less overload at increased heads.
- Peak performance at 40 to 60% of shut-off head.

Principal Applications:

Raw water intake; Low lift transfer; Dewatering; Spray pools; Sewage effluents.

Primary Users:

Power plants; Sewage treatment installations; Flood control; Land reclamation; Steel mills, refineries, chemical plants, etc.

For complete details and specifications, call or write your nearest Johnston distributor or contact the factory direct.

JOHNSTON PUMP COMPANY

A DIVISION OF THE YOUNGSTOWN SHEET AND TUBE COMPANY

3272 East Foothill Boulevard, Pasadena, Calif.

Branch Warehouses: Roswell, N. M.; Hastings, Neb.; Pecos, Texas; Idaho Falls, Idaho

YOUR *New Catalogs* GUIDE

45 ENGINE POWER TAKE-OFFS

Rockford Clutch Div., Borg-Warner Corp.—Circular is available containing illustrations, line drawings, description, and complete information on size and capacity of this unit designed for especially rugged heavy-duty service, operates without a pilot bearing and requires lubrication only once per year.

46 HEAT TREATING BASKETS

Ipsen Industries, Inc.—Bulletin HTB-60 presents a line of heat treatment baskets of Inconel for use in controlled atmosphere and vacuum units. Table of sizes is given.

47 AIR DIAPHRAGM CYLINDERS

Westinghouse Air Brake Co., Industrial Products Div.—A four-page catalog illustrates and describes diaphragm air cylinders and diaphragm air chambers with effective areas from 9 to 50 sq in. and strokes from 1¾ to 4 in.

48 PLASTICS RESINS

E. I. duPont de Nemours & Co.—Catalog A-15427 illustrates and describes characteristics forming and working techniques, and end-use applications of Delrin acetal resin, Zytel nylon resin. Alathon polyethylene resins and Lucite acrylic resin. Detailed properties charts are listed.

49 PRECISION MEASUREMENT

Sheffield Corp.—A 22-page brochure describes the precision measurement and inspection services of the firm's Eli Whitney metrology laboratory. Services include calibration and certification of gage blocks, roundness determination, hardness testing, surface finish analysis, thread and plug gage calibration.

50 DIAPHRAGM VALVES

Grinnell Co.—An 8-page catalog describes diaphragm valves offering streamlined fluid passage, flow control, leak-tight closure. Isolation of working parts from fluid stream is said to prevent product contamination and corrosion of operating mechanism. Flexibility of assembly and wide choice of materials for bodies, body linings and diaphragms are described.

51 STAINLESS STEEL

Sharon Steel Corp.—A 32-page catalog offers description, chemical composition, strength factors, physical properties and applications for stainless steels, including the 200, 300, and 400 series. Forging ingots and rolled-in surface patterned stainless steels are included.

52 THERMOSTATS

Norwalk Thermostat Co.—Leaflets describe the line of bimetal thermostats. Different types are illustrated and described, including Types A, B, AP, ADP, and other types.

53 PACKAGED BOILERS

Cleaver-Brooks Co.—Bulletin AD-137 which describes the specific advantages of packaged fire tube boilers and Springfield water tube boilers. It includes dimensions, ratings, and boiler room layout data.

54 DRAINLINES

Corning Glass Wks.—Eight-page, two-color bulletin on Pyrex pipe for drainlines contains case histories. Photos show installations, methods of installing, fittings available, ways to fabricate odd lengths on the job. Check list of acids to which the pipe is resistant is also included.

55 AXIAL FLOW PUMPS

Allis-Chalmers Mfg. Co., Hydraulic Div.—Axial flow pumps of adjustable and fixed blade types are described in Bulletin 02B9229. They are applicable for heads ranging from 5 to 55 ft. and have been built in sizes from 11 to 150 in. in diameter with discharges from 3000 to 900,000 gpm. Bulletin includes settings, preliminary sizing data, specifications, application.

56 BURNISHING TOOLS

Gustav Wiedeke Co.—This bulletin includes tool specifications for sizes ⅜ in. through 7½ in. diameter automatic roller type burnishing tools. Information on part preparation and operating instructions are also included.

YOUR

New Catalogs

GUIDE

57 VARIABLE SPEED DRIVES

Electric Machinery Mfg. Co.—A two-page leaflet describing a line of variable speed, magnetic drives from 5 to 300 hp. Leaflet shows construction by cut away views. The drives are used as a variable speed source for pumps, fans, and blowers. Said to be particularly adaptable for sewage pumping, the units mount between the drive motor and the pump.

58 OIL/GAS BURNERS

Wickes Boiler Co.—Bulletin 58-1 provides information on oil/gas burners for shop-assembled and field erected boilers suitable for automatic combustion and safety controls. Single or multiple burner arrangements are shown. The burners are of steam, or air atomizing type for oil, center ring type for gas.

59 PLANT ENGINEERING EQUIPMENT

B-I-F- Industries, Inc.—Bulletin 0001.20-1 provides information and illustrations of the firm's line of process instrumentation and equipment for positive control of materials in motion. Included are meters, feeders, valves, weighers, instrumentation, controls, and systems.

60 TOOL STEELS

Crucible Steel Co. of America—A six-page index to Crucible tool steels and AISI type classifications. The cross index is an aid to making an accurate identification and selection of tool steels for specific jobs.

61 ALUMINUM PIPING

Aluminum Co. of America—Eight-page booklet describes product piping with integral steam tracing (Unitrace) and the family of fittings that have been developed for it. A 26-page booklet contains information, complete with 16 pages of drawings to simplify installation of the unit.

62 SOLENOID VALVES

Johnson Corp.—Bulletin V covers direct-operated solenoid valves for automatic, or remote, flow control of water, air, gases, and liquids of all types. Design features include: coil offset from heat of line; bolted bodies; floating seats. Sizes are from ⅛ in. to 3 in. in normally open or closed, three-way and explosion-proof types.

63 DRAWING PENCILS

Eberhard Faber Pen & Pencil Co.—New Microtomic circular and two-page, full-color insert sheet illustrates and describes line of drawing pencils and draftmen's erasers. Also, a sheet describes new Microlar line of pencils for use on coated drafting surfaces.

64 ANNUNCIATOR SYSTEMS

Panellit, Div. of ISI, Inc.—Catalog 100-C describes annunciator systems. The function, benefits, and selection of Panalarm annunciator systems are discussed. Included in this 50-page catalog are dimensions, plug-in relays, remote equipment and components, accessories, engineering data and ordering information.

65 SURFACE HARDENING STEELS

The Chapman Valve Mfg. Co.—Bulletin describes Chapman's process for surface hardening alloy steels. Process known as NI-20 is claimed to reduce time cycle requirement to produce greater case depths and higher wear resistance. Bulletin also provides new technical data on Chapman's malcomizing process.

66 REVERSING TRANSMISSIONS

Snow-Nabstedt Gear Corp., Industrial Div.—Catalogs are available on four models of reversing transmissions containing technical engineering information, and all specifications. Units are designed for maximum 8 and 28 hp with 2000 rpm input limit. Each model has forward, neutral, reverse, and reduction, or can be supplied with two speeds forward, and can shift under full load.

67 STANDBY ELECTRIC PLANTS

D. W. Onan & Sons Inc.—Beginning with the need for standby power, eight-page folder outlines the steps to be considered in the selection of any emergency electric generating plant. Suggestions are offered in the planning and designing of the installation, the degree of protection desired, "musts" to consider, and errors to avoid.

Reliance EYE-HYE®

the first successful

remote reading water level gage

known to American engineers

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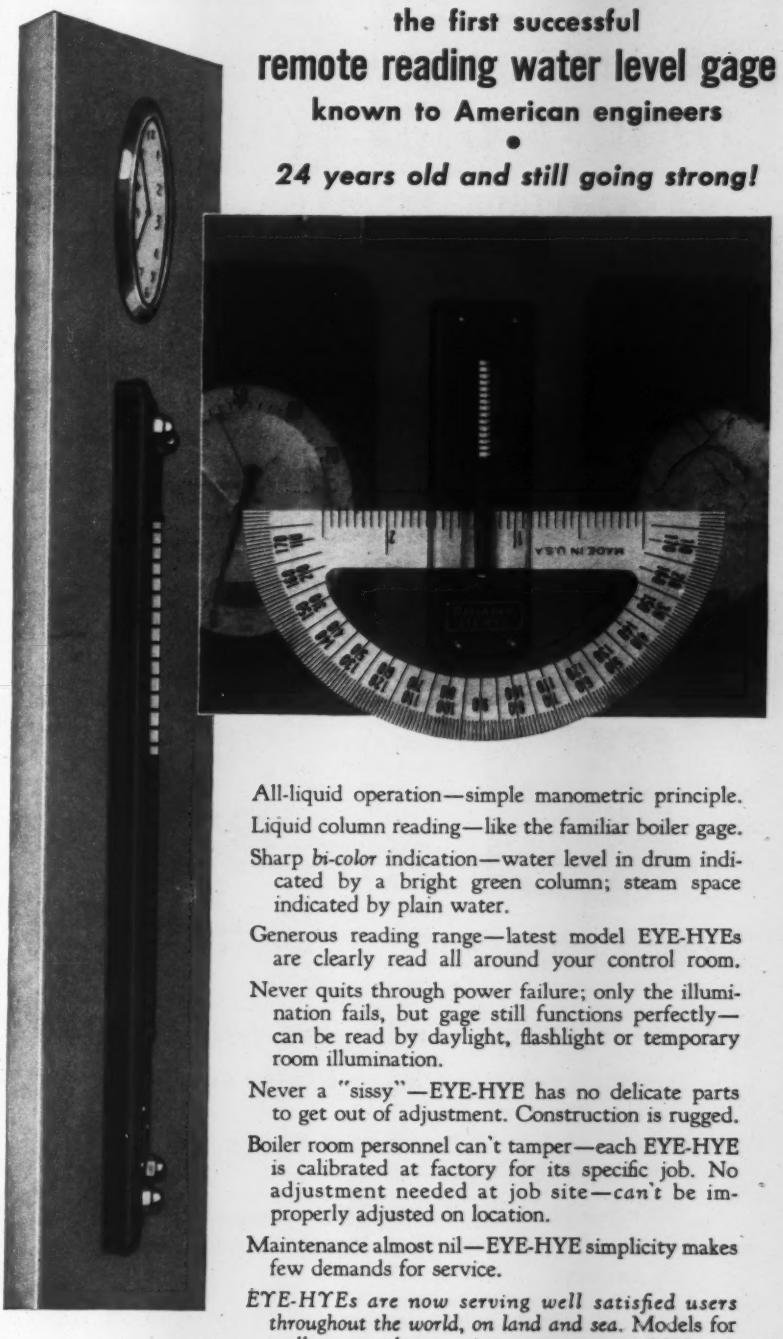
24 years old and still going strong!



All-liquid operation—simple manometric principle.

Liquid column reading—like the familiar boiler gage.

Sharp *bi-color* indication—water level in drum indicated by a bright green column; steam space indicated by plain water.

Generous reading range—latest model EYE-HYEs are clearly read all around your control room.

Never quits through power failure; only the illumination fails, but gage still functions perfectly—can be read by daylight, flashlight or temporary room illumination.

Never a "sissy"—EYE-HYE has no delicate parts to get out of adjustment. Construction is rugged.

Boiler room personnel can't tamper—each EYE-HYE is calibrated at factory for its specific job. No adjustment needed at job site—*can't* be improperly adjusted on location.

Maintenance almost nil—EYE-HYE simplicity makes few demands for service.

EYE-HYEs are now serving well satisfied users throughout the world, on land and sea. Models for wall or panel mounting; pressures to 3000 psi. Write for EYE-HYE catalog material.

The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio

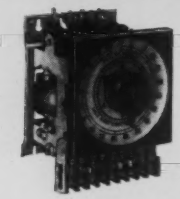
Reliance

BOILER SAFETY DEVICES

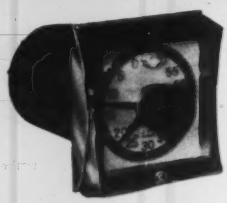
EAGLE

QUALITY BUILT • EASY TO USE

timers and counters



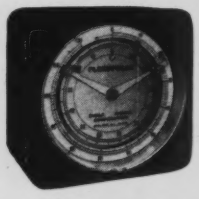
Bulletin 110
20 TURN DIAL RESET TIMER



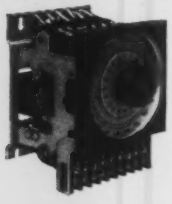
Bulletin 125
SINGLE CYCLE RESET TIMER

Bulletin 165
PNEUMATIC TIME DELAY RELAY

Bulletin 170
TIME DELAY RELAY



Bulletin 320
ADJUSTABLE REPEAT CYCLE TIMER



Bulletin 720
AUTOMATIC RESET COUNTER

Now in stock for immediate delivery

To better serve your needs without delay, EAGLE now makes available the above Timers and Counters for immediate delivery direct from factory stock or stocking sales representatives in principal cities.

When you use EAGLE Timers and Counters, you are assured of selecting the finest quality and most dependable components you can buy.

Write us regarding your TIME-COUNT problems, or see your local phone directory or Thomas Register under the heading, "TIMERS, ELECTRIC" for your nearest EAGLE Representative.

BLISS

EAGLE SIGNAL COMPANY • Moline, Illinois

A DIVISION OF THE GAMEWELL COMPANY, AN E. W. BLISS COMPANY SUBSIDIARY

MANUFACTURERS OF THE MOST COMPLETE LINE OF INDUSTRIAL TIME-COUNT CONTROLS

YOUR

New Catalogs GUIDE

68 OPTICAL INSTRUMENTS

Bausch & Lomb—A booklet, "Industrial Optical Aids," contains information on an assortment of inexpensive precision optical instruments and suggests ways to use them to gain faster, easier, lower-cost production. Items discussed include magnifiers, microscopes, wide field tubes macroscopes and comparators. Catalog D 1059.

69 BEARING CUPS, CONES

Timken Roller Bearing Co.—An illustrated brochure tells how the company's continuous high-speed production methods at its Bucyrus, Ohio, plant is holding down bearing costs and explains how manufacturers can benefit from these economies. Includes price index history demonstrating what these economies mean to the automotive industry. Back cover chart shows the 30 bearing cups and cones in the Green Light series which covers bore sizes from .7500 to 2.625 in.

70 HEATERS, HEAT EXCHANGERS

Patterson-Kelley Co.—Catalog No. 202 contains 36 pages of product data and application tables for instantaneous hot water heaters and heat exchangers. Data includes dimensions, standard connections, piping arrangements, and diagrammed line drawings of two-, four-, and six-pass instantaneous heaters, plus condensate coolers (or preheaters) and booster heaters constructed in accordance with ASME code requirements.

71 HYDRAULIC PUMP SELECTION

Blackmer Pump Co.—A 32-page technical manual outlines procedure for making pump selections. Bulletin shows easy method of analyzing suction and discharge conditions, provides definitions of common hydraulic terms plus direct-reading tables for determining pipe friction losses. Additional tables show physical properties and pump construction for over 100 common liquids.

72 WATER COLUMNS, GAGES

Ernst Water Column & Gage Co.—Bulletin 5-2-60 illustrates and gives specifications of bronze gages, flow indicators, water columns, steel gages and valves, gage glasses and gaskets.

73 DUCTILE IRON VALVES

Stockham Valves & Fittings—Ductile Iron Catalog No. 1 describes line of ductile iron valves and fittings. Valves are rated at 150 lb. Sizes range from 2 to 16 in. Fittings are rated at 300 and 500 lb.

74 SLUDGE COLLECTORS

Link-Belt Co.—"Circuline Sludge Collectors" Book 2546, presents line of six series and 15 types of Circuline collectors available for water, sewage, and industrial waste treatment settling tanks. The 28-page book announces two new series and six new types of collectors. With detailed engineering drawings and data, the book contains two tables: one gives the required surface area for various flows and surface loadings for a given settling tank size and the other shows how to determine tank dimensions, volume, and weir length.

75 MICROFILM REPRODUCTION SYSTEMS

Charles Bruning Co.—An eight-page booklet explains microfilm systems that can be set up with Bruning equipment. Flow charts show how microfilm aperture cards can be used to file drawings, to dispose of obsolete drawings, to make duplicate drawings, and to set up an extensive reference and reproduction system.

76 SOCKET-HEAD SCREWS

Set Screw & Mfg. Co.—A 28-page catalog on socket screw products includes a selection of standard and special set and socket head screws. Included are socket shoulder screws, flat heads, button heads, and dowel pins. A feature of the catalog is the inclusion of the Setko originated self-locking set screw selector chart.

77 STEAM GENERATOR

Ames Iron Wks., Inc.—Bulletin AA-3 describes advantages of a newly designed low pressure air atomizing burner and new gas ring burner. The Model AA incorporates a 3-pass concentric tube design, single one-piece baffle, and one-piece flue covers.

YOUR

New Catalogs GUIDE

78 FILTERS

Air-Maze Corp.—General catalog describes entire line of air filters and liquid filters, including oil bath air filters for engines, compressors, blowers, heating and ventilating filters and electrostatic precipitators, all metal, cleanable liquid strainers offering down to 10μ filtration, intake silencers, exhaust spark arresters.

79 TORQUE WRENCHES

P. A. Sturtevant Co.—Torque Manual contains 31 new pages of application illustrations, bolt charts, discussions on assembly characteristics, instructions for torque wrench testing, pictures of modified and special torque wrenches, formulas and illustrated explanations for using adapters, attachments, and extensions.

80 HIGH-TEMPERATURE THERMOCOUPLES

Aero Research Instrument Co.—Product Information Report 8.1 covers thermocouple-type temperature sensors for use up to 4000 F. They are of the cooled and noncooled types to measure liquid, solid, and gaseous temperatures. Refractory metals with oxidation resistant coatings are used. Data on temperature-emf relationships, time response characteristics, temperature limits of materials and detailed drawings of the sensors are included.

81 GLASS VACUUM SYSTEMS

Delmar Scientific Laboratories—Glass High Vacuum Systems catalog is devoted exclusively to standard and custom built glass vacuum systems. It contains a complete description of parts and many accessory items. There is also detailed information on installation and applications of these systems.

82 SOLENOID VALVES

Fluid Power Accessories, Inc.—Line of two-way and three-way solenoid valves for pressures to 3000 psi are featured in bulletin. Hardened and ground steel working parts are in aluminum housing. Two-way valves are available in 1/4, 3/8, and 1/4 in. NPT for a-c and d-c voltage. Three-way valves are available in 3/8 in. NPT size for a-c voltage maximum working pressure is 2000 psi for immediate shipment.

83 MATERIAL HANDLING CONVEYERS

Samuel Olson Mfg. Co., Div. of Cherry-Burrell Corp.—A 20-page catalog, No. 1000C, covering light, medium, and heavy duty conveyers for handling containers, packages, fabricated parts or assemblies. Catalog includes descriptions of conveyer applications, dimensional drawings to assist engineers and photographs of typical installations of roller, spiral, slat, pusher bar, chain, belt, vertical reciprocating and suspended tray conveyers.

84 STEAM TURBINES

Terry Steam Turbine Co.—Bulletins in looseleaf form which cover a complete description of Terry solid wheel turbines with cross section drawings of typical units for both moderate and high steam pressure conditions: a description of the Terry axial flow impulse, both single state and multistage; Terry gears which are used for speed increasing and speed reducing.

85 CONTROLS AND GAGES

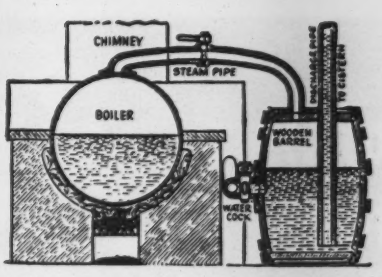
F. W. Dwyer Mfg. Co.—The complete gage and control catalog contains illustrations, prices, and full details on The Dwyer Magnehelic gage, manometer, air velocity meters, air filter gages, pitot tubes, pressure-actuated switches, flowmeters, combustion testing instruments, conversion curves and other engineering data.

86 MULTI-DRIVE COMPRESSOR UNITS

Dunham-Bush, Inc., Brunner Div.—The Brunner line of multiple drive compressors, 7 1/2 through 40 hp is described in Bulletin 775. In addition to product features, specifications are listed for refrigeration compressors, semihermetic, direct drive condensing units, and compressors. Capacity curves are presented.

87 ELECTRONIC SCALES

Streeter-Amet Co.—Brochure on Ametron electronic scales, "The Way to Weigh," is illustrated with graphs, charts, and photographs. Types are crane, tank, hopper, car, truck, and track scales. Basic instruments are described and the accessories for these units are also presented.



AN ENGINEERING FRONTIER IN 1663...

. . . was finding ways to utilize steam power. In that year, for example, the Marquis of Worcester is credited with inventing the ingenious "steam water lift" shown here. Steam from the boiler passed through a pipe into a wooden barrel. Steam was condensed in the barrel, creating a partial vacuum, which caused water below to rise into the barrel when the water cock was open, When the cock was closed and the steam valve opened, the steam forced the water up through a discharge pipe into a cistern above. It was through trial and error designs like this that the art of steam power generation was first introduced.

AN ENGINEERING FRONTIER IN 1960...

. . . is the development of commercial nuclear power utilizing such modern reactors as the Combustion Engineering design illustrated. Nuclear reactor systems capable of generating economical steam power for commercial use have long been an engineering goal in the American power industry.

Combustion Engineering, recognized internationally as a pioneer in the fast-moving technology of steam power generation, has developed in its Nuclear Division the engineering capability necessary to the successful pursuit of this goal. All of the elements essential to the design and development of well-balanced, high-performance reactor systems are under constant investigation by individuals skilled in the fields of engineering, physics, metallurgy, ceramics and chemistry. Staff positions are now available to individuals qualified in these disciplines.

During 1959, more than 30 large C-E steam generating units with a total capacity of over 5 million kilowatts were installed in utility power stations in this country and abroad. The generation of commercial nuclear power is a natural extension of our product line.

Address inquiries to:
Mr. R. M. Killelea, Manager,
Professional Recruiting, Nuclear Division,
Combustion Engineering, Inc.,
Windsor, Connecticut

NUCLEAR DIVISION

COMBUSTION ENGINEERING, INC.

"Living metal" bellows function to the nth degree!

You name the degree of temperature to be met . . . in friction-tortured nose-cone or near-absolute testing chamber.

You name the rigorous stresses to be encountered . . . the severe pressures or corrosive atmospheres.

You name the problem . . . and our engineers will deliver a "living metal" bellows assembly that answers it!

Custom-designed and manufactured by the company that invented the seamless metal bellows, Robertshaw Sylphon® Bellows are available in a wide variety of metals, according to the properties desired . . . brass, phosphor bronze, beryllium copper, monel, A-286 stainless steel, inconel, inconel-X and now in Ni-Span-C.

Robertshaw Bellows Assemblies may be the answer to many of *your* problems . . . and we think you'll find a world of information and suggestions in our comprehensive Catalog VK-R. Why not write for it today?

Robertshaw®

MR. CONTROLS

Robertshaw-Fulton Controls Co.

FULTON SYLPHON DIVISION, KNOXVILLE 1, TENNESSEE

YOUR *New Catalogs* GUIDE

88 MECHANICAL DIFFERENTIAL

Ford Instrument Co., Div. of Sperry Rand Corp.—A data sheet illustrates and describes the 1/32 in. standard differential. This unit is the latest and smallest addition to the company's line of single spider-gear differentials.

89 CORROSION CONTROL

D. W. Haering & Co.—Revised edition of "Solution to Your Problem of Scale and Corrosion Control" is in the form of a telescoped sheet of eleven different drums, each a Glucosate directed to some special use in correcting and controlling scale and corrosion factors.

90 STEELS

Allegheny Ludlum Steel Corp.—Booklet SS38 describes melting techniques and resulting quality characteristics in high temperature-high strength alloys, stainless and low alloy steels, bearing steels, tool steel, and various electrical grades. Included are consumable electrode vacuum remelting, induction vacuum melting, special quality air melting and vacuum degassing processes.

91 MACHINE CONTROL EQUIPMENT

Cimtrol Div., Cincinnati Milling Machine Co.—Illustrated folder outlines the advantages of the Acramatic Numerical Control System. Pockets in the folder contain data sheets on applications of contouring and positioning controls for original equipment builders.

92 SPUN STEEL TUBING

American Cast Iron Pipe Co.—Illustrated 64-page catalog describes special products division facilities, the centrifugal spinning process, its advantages and illustrates versatility of application of tubes. It contains tables, technical data, engineering information for stainless and carbon steel tubes 2.25-50 in. od.

93 DIESEL, DUAFUEL ENGINES

Nordberg Mfg. Co.—Series 29, two-cycle diesel and Duafuel engines for stationary and marine service are described in a 16-page bulletin, No. 235A. With 29-in. bore and 40-in. stroke these engines are claimed to be the most powerful single action, two-cycle engines built in America.

94 TIMERS, COUNTERS

Eagle Signal Co., Div. of Gamewell Co.—Bulletin 10 illustrates and describes single cycle reset timers, manual timers, time delay relays, repeat cycle timers, preset counters, step switches, and hermetically sealed timers designed to military specifications.

95 CHECK VALVES

Miller Valve Co.—Sizes 1 through 20 in. and pressures 125 to 2500 lb are covered in Catalog 162. Specifications and dimensions are given. A table of friction of water in pipes, and a pressure drop curve are included.

96 PLUNGER PUMPS

Kobe, Inc.—Bulletin describes high pressure triplex plunger pumps and their applications. Outstanding design feature is lap-fitting plungers and liners which are said to eliminate packing maintenance. Continuous duty ratings to 20,000 psi and to 60 hp. Range of temperature is +1000 F, and −320 F.

97 COPPER, COPPER ALLOYS

Anaconda American Brass Co.—A 32-page reference booklet on corrosion resistance of copper and copper alloys covers continuous laboratory research and field study of the nature of corrosive attack on these metals conducted for a period of 31 years by the company's technical staff. Latest findings are incorporated in the text of Part I, "Theory of Corrosion and Types of Corrosive Attack."

98 SCREW THREAD STANDARD

Scherr-Tumico Co.—Caging requirements of Federal Screw Thread Standard H-28 are discussed and described in a ten-page booklet "Gaging Screw Threads for Acceptability." Booklet is illustrated.

YOUR

New Catalogs

GUIDE

99 FLUID COOLING SYSTEM

Niagara Blower Co.—Bulletin No. 132 illustrates with diagram and photographs method of evaporative cooling with automatic close temperature control, completely self-contained. Unit capacities are to thirty million Btu. Method can be applied to cooling all liquids and gases and condensing vapors. Heat may be removed or added.

100 PRESSURE REGULATORS

American Meter Co.—Bulletin 130 covers Series 100 and 200 pressure regulators used for reduction, relief and back pressure applications in transmission, distribution and industrial installations where accuracy, sensitivity, and reliability with minimum maintenance are important. Maximum inlet pressure is 1200 psi; maximum outlet pressure 150 psi, or 600 psi with pilot loading. Bulletin 131 describes Series 300 low-pressure regulators, designed for similar application on low-pressure systems. Maximum inlet pressure is 400 psi, maximum outlet pressure 14 in. w.c.

101 VALVES

J. H. H. Voss Co.—Bulletin 53-G covers valves for air, gas, or ammonia compressors. The valves are machined from solid stock; plates are machined and ground; valves and plates are of heat treated alloy or stainless steel, custom designed for individual characteristics of compressor.

102 ELECTRIC MOTOR CONTROLS

Furnas Electric Co.—Catalog 5900 gives information on application and selection of electric motor control. Included is engineering data, such as wiring diagrams, horse-power ratings, motor speeds, heater sizes, as well as other design information. Manual and magnetic starters, drum controllers, pressure switches, definite purpose control, and various pilot devices and accessories are covered.

103 WELDING ALUMINUM

Aluminum Co. of America—A 176-page hard cover book gives basic, practical data on the various processes for welding aluminum with special emphasis on the inert gas methods. Included is guidance in selecting the process and the alloy. One chapter is devoted to the performance of welds. Illustrated, 32 tables. Form 10415.

104 CHAINS AND SPROCKETS

Link-Belt Co.—Stock sizes of Link-Belt roller chains and sprockets are listed in 44-page book, No. 2757. The book lists over 2000 types and sizes of stock roller chains and sprockets including standard and double pitch power transmission chains, a large selection of conveyer chains and attachments, and the line of sprockets.

105 AUTOMATIC CONTROLS

Mercoid Corp.—Catalog No. 860, a 64-page reference book for engineers, contains information on automatic controls for pressure, temperature, liquid level, and mechanical movement. Transformer-relays and mercury switches.

106 FINNED TUBING

Griscom-Russell Co.—Bulletin ES-2 illustrates and describes helical and longitudinal finned tubing and pipe from $^{5}/_{16}$ in. od to 6 in. ips with $^{3}/_{32}$ to $1^{1}/_{4}$ in. fins in a wide range of fin spacing. Tubing is available in many metals and combinations to meet the problems of corrosion, temperatures, cost and thermal conductivities.

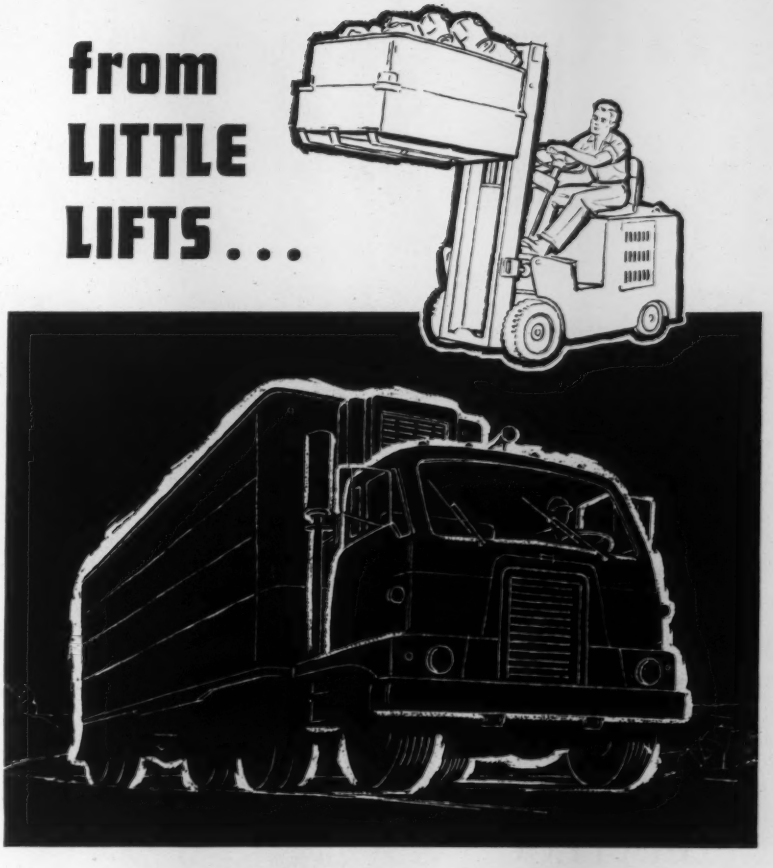
107 VERTICAL FOUR-SLIDE MACHINE

Torrington Mfg. Co.—Bulletins V-80, V-81, V-82, and V-83 detail operating features, specifications for new Verti-Slide all-purpose vertical four-slide machine. Design details and component functions are given for feed mechanism, cam and cam shafts, drive system, and presses. Photos illustrate operation of slides, slide bases, center former, lubrication system, and clutch.

108 TEMPERATURE REGULATORS

OPW-Jordan Corp.—Eight-page Catalog J180-1 describes the line of sliding gate regulators. Sizes are $^{1}/_{4}$ to 6 in. Self-operated, pilot-operated, and combination temperature and pressure regulators are described.

from LITTLE LIFTS...



to SUPER SEMIS

Both are driven by Rockford Spring-Loaded Clutches. Rockford offers today's design engineer an ultra-wide range of proven power controls for automotive, agricultural and industrial machinery. Rockford's complete engineering design service is available to you at no cost or obligation. All clutches are quality-built and thoroughly tested for enduring dependability . . . customers stay customers. Write today for illustrated brochure.

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ROCKFORD B-W CLUTCH

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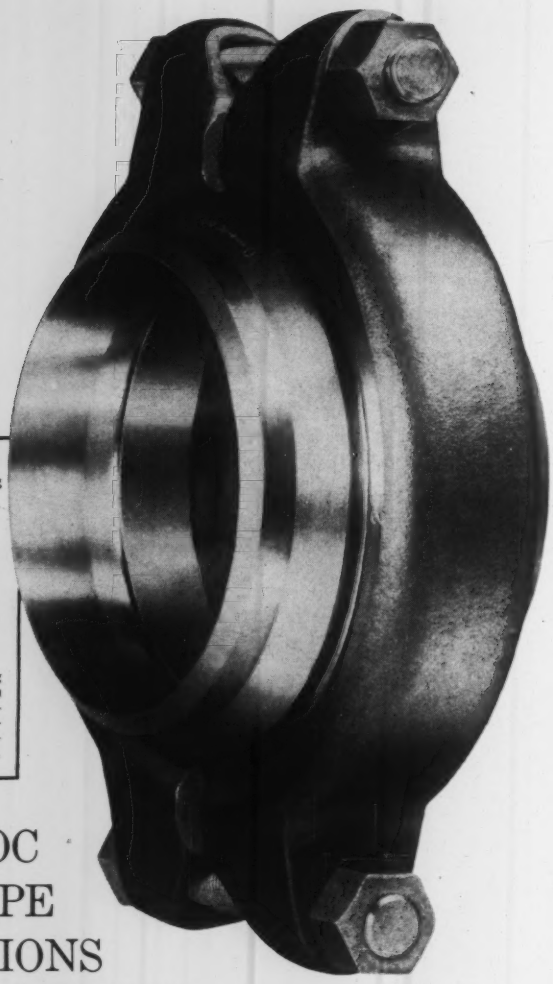
Taper angle of seal-ring lips is slightly less than that of mating hubs. Tightening clamp causes seal-ring lips to deflect, forming seal by spring action.



GRAYLOC PIPE CONNECTIONS HOLD PRESSURE WITHOUT LEAKING

From a full vacuum to extreme internal pressure, GRAYLOC pipe connections will not leak—will not blow out.

It's an all steel assembly with a pressure aided seal that can be quickly and easily disconnected. The seal ring is even re-usable! Yet, for all its sealing power, it's lightweight and small in size.

GRAYLOC pipe connections are manufactured in standard stock sizes from 1″ to 30″, but special sizes can be manufactured on request. They are also available made of corrosion resistant metals.

Learn how GRAYLOC pipe connections can save you time, space and money. Write for the all new GRAYLOC catalog.

GRAYLOC SALES DIVISION

GRAY Tool Company

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YOUR *New Catalogs* GUIDE

109 SUBMERSIBLE PUMPS

Layne & Bowler, Inc.—Bulletin 202 describes applications for deep well submersible pumps with a detailed cut-away of the pump.

110 CONTROLLED-AIR-DEVICES

Bellows-Valvair—Bulletins BM-25 and ML-5 illustrate and explain air motors and the choice of built-in valves and auxiliary hydraulic controls available for them. Bulletin ML-5 also describes the basic types of complete-work-units, such as power feeds, work feed tables, drilling units. Both booklets contain application photographs.

111 BALL VALVES

Hills-McCanna Co.—A 32-page catalog describes entire line of top-entry and bar stock ball valves. It includes temperature and pressure charts, dimensions, weights; Cv ratings, vacuum service data, corrosive service recommendations, air operators, PVC valves, special service valves, and other informative engineering data.

112 HYDRAULIC FLUIDS

Vickers Inc.—A 24-page catalog, No. 1300SA, describes the selection, operation, and maintenance or hydraulic fluids for industrial machinery. It contains information on general qualities, lubricity, viscosity, viscosity index, oxidation resistance, neutralization number, rust and corrosion, demulsibility, foam, cavitation, additives and fire-resistant fluid selection.

113 STAINLESS STEEL FITTINGS

Ladish Co.—An 86-page master reference volume on stainless steel pipe fittings gives information on broad line of IPS and tube OD fittings, ASA, MSS and corrosion weight flanges. Technical section includes manufacturing standards, specifications, corrosion resistance tables, and data on welding of stainless steel.

114 HEAT EXCHANGERS

Southwestern Engineering Co.—Catalog describing heat exchangers and pressure vessels which are designed, engineered, and manufactured for the process and power industries. Photographs and diagrams illustrate basic types and other special process and power equipment such as feedwater heaters, surface condensers and steam jet ejectors.

115 BRASS MILL TERMS

Anaconda American Brass Co.—A 24-page illustrated lexicon called "Copper & Copper Alloy Metalexicon" untangles complex terminology applied to brass mill products.

116 WELDED STEEL PULLEY

Link-Belt Co.—Book 2540, 8 pages, describes a new hydro-expansion-formed belt conveyor pulley designed to increase conveyor belt life, has a 25 per cent greater strength, is concentric to within 0.030 in. and is free from crown welds.

117 THIN WALL INSERT

Rosan, Inc.—Literature describes high strength insert trademarked Slimsert. Serrated top external threads provide anti-rotational lock. Inserts are designed with 6 and 4-point internal drive. Available in sizes No. 4 through 1/2 in. in either Armco 17-4PH stainless steel or high-strength aluminum alloy.

118 WATER TREATMENT EQUIPMENT

Permutit Co. Div., Pfaudler Permutit Inc.—A bulletin gives data on aerators, degasifiers, deaerators, chemical feeders, precipitation equipment, filters, ion exchange equipment, gas analysis and control systems, valves, meters, flow controllers. Application photos show the equipment in various industries.

119 FLEXIBLE SHAFT ASSEMBLIES

F. W. Stewart Corp.—Illustrated catalog describe Circle Ess flexible shaft assemblies in four cable sizes, 0.130, 0.150, 0.187, and 0.250 in. in monodirectional or bidirectional types. Choice of three to four end fitting combinations are offered on either end of the assembly.

YOUR

New Catalogs GUIDE

120 CEMENTED CARBIDES

Kennametal Inc.—A 24-page booklet illustrates by examples how the use of Kennametal and Kentanium increases productivity and reduces costs in many different industries; lists properties and typical applications of Kennametal, Kentanium, refractory carbides, heavy tungsten alloys, niobium, and tantalum.

121 DUST COLLECTORS

Torit Mfg. Co.—Six-page Folder No. 359 pictures and describes two types of Torit dust collectors, the cabinet cloth filter type and the centrifugal separator. Sixteen models are shown with their specifications, with typical installations. Torit's diamond dust collector, an exhauster, and several accessories also are pictured.

122 AIR CONDITIONERS

Modine Mfg. Co.—Bulletin illustrates and describes a new line of self-contained, through-the-wall room air conditioners. Units utilize a fully hermetically sealed refrigerant cycle combined with heating coils for connection to hot water or steam systems. Models also available with electric heating element.

123 AIRCRAFT TEST STANDS

Ledeen Mfg. Co.—Folder describes air-hydraulic aircraft test stands, designed for testing aircraft hydraulic systems and checking and calibrating gages, pressure switches, relief valves, and other instruments. Stands operate off plant air system.

124 CENTRIFUGAL PUMPS

Worthington Corp.—Bulletin 2131-B1 illustrates and describes 2- and 4-stage centrifugal pumps for boiler feed and general medium pressure services in pressures to 750 psi and capacities to 2500 gpm. Cross-section and dimensional diagrams of the units are included, along with information on writing specifications.

125 FIRE-RESISTANT FLUIDS

Shell Oil Co.—A technical bulletin gives detailed information on synthetic fire-resistant hydraulic fluids. Data covers applications, operating advantages, procedures for changing systems and packings, gaskets, paints, and seals.

126 WORM GEAR JACKS

Duff-Norton Co.—Eight-page bulletin, No. AD-66, describes how two or more jacks can be tied together in a jacking arrangement by means of couplings, shafting, and mitre gears boxes. All jacks will raise and lower in unison and arrangements can be motor driven. Jack capacities range from two to one hundred tons. Specifications and dimensions drawings are included.

127 BOILERS, BURNERS

American-Standard Industrial Div.—Loose-leaf binder with separate sheets for each series of Kewanee boilers and boiler-burner package units available includes cutaway drawings, descriptions, specification data and dimensions, and sample specifications. Residential, firebox, and scotch-type boilers are covered, ranging to 651 hp.

128 ANALOG COMPUTING COMPONENTS

George A. Philbrick Researches, Inc.—Brief catalog, four pages, describes typical instruments from operational amplifiers, manifolds, linear and non-linear operators and power supplies, to a fully integrated display system that affords instantaneous and automatic calibration for voltages and time (up to eight variables) on screen of a standard oscilloscope.

129 HEATING AND COOLING UNIT

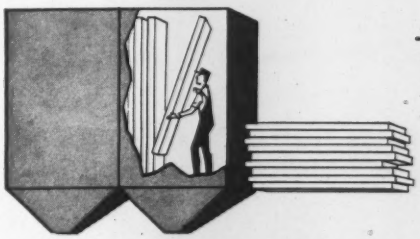
Mammoth Industries, Inc.—YR series enclosed weatherproofed "Compact-Aire" roof top heating cooling unit for outdoor installation is described in Bulletin YR-460. Units are available in four sizes with Btu outputs, gas or oil, from 150,000 to 500,000. Coil space, blower capacities can handle any standard cooling equipment from 3 to 20 tons.

130 ROTARY SLITTING LINES

Yoder Co.—A 75-page handbook provides information on slitters and allied equipment. Basic data on design, selection and operation of slitting lines, and specifications of slitters, uncoilers, recoilers, coil cars, and scrap choppers are included.

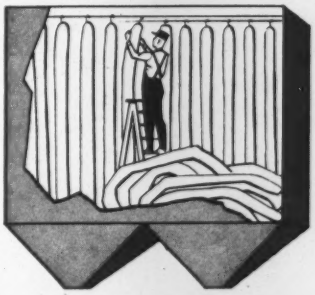
SINCE 1874 SLY

SLY DUST FILTERS For ACCESSIBILITY



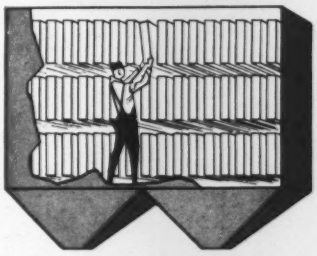
1900's
SLY DUST ARRESTER

Every cloth screen from the end of the arrester had to be removed to reach the faulty screen.



1930's
SLY TUBE-TYPE FILTER

To replace a tube required at least partial disassembly of every other tube in the way.



TODAY
NEW SLY
"ROLL-CLEAN"
DYNACLONE®

Any filter bag is easily accessible and can be replaced without need for removing others.

NEW SLY DYNACLONE PROVIDES FASTEST, EASIEST BAG CHANGING

Whether you change one bag, or the entire filter, you do it in less time with the Dynaclone. Quick replacement of individual bags eliminates the need for costly rebagging should only a few be worn. Complete change is also fastest . . . the Dynaclone has only one half as many bags as other filters with the same cloth area. In addition . . .

New "Resist-O-Wear" bags offer 200 to 300% more bag life.

The Dynaclone operates continuously. It provides complete dust suppression through constant suction.

The Dynaclone is automatically self-cleaning by reverse air. A single exhaust fan provides *both* suction for dust collection and air for bag cleaning. No auxiliary blowers required.

And the Dynaclone provides 20 to 40% more cloth in a given space than other makes of dust filters.

The Dynaclone has been proved in more than 1,000 installations. Investigate its advantages on your applications . . .

SEND FOR 36-PAGE CATALOG 104

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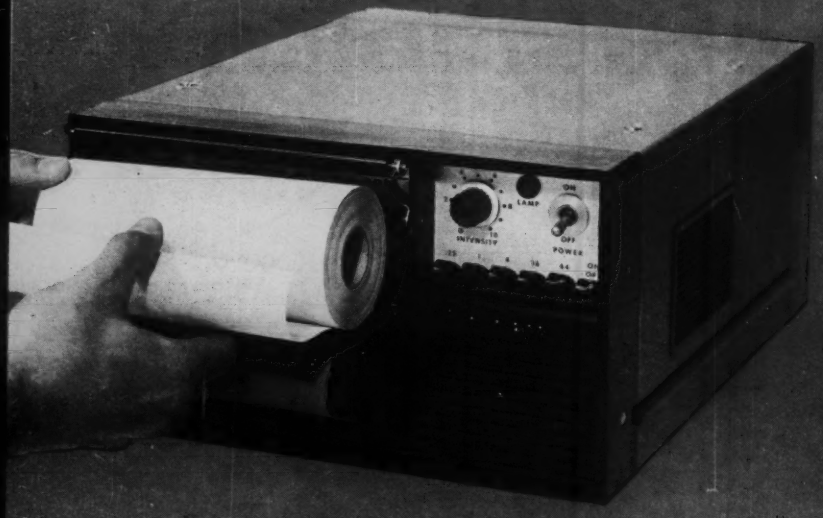

NEW...THE EASIEST LOADING AND OPERATING RECORDING OSCILLOGRAPH AVAILABLE!

Just ten seconds! That's all it takes to drop in a roll of paper, push the button and you are recording 18 channels of data. No magazine or threading and operation is practically foolproof. Want to change recording speeds?... 1/4, 1, 4, 16, 64 inches per second? Just push a button.

The record is made by the print-out process, so there's nothing to do but watch it happen. No processing. It's right there in front of you. In fact, everything is in front: loading, controls, operating, viewing. And you can tuck it away in a rack without need for top or side clearance.

The 5-124 has 18 individual plug-in inputs to afford you the greatest flexibility in handling your data lines. It's a "big" oscillograph in a very small package. Even with its 7-inch-wide record and regulated power supply, it's portable. Carry it anywhere.

Economical to buy? About $500 more economical than the basic cost of a comparable unit. And the 5-124 is available with many optional features to meet your knottiest data recording problems.

Five-speed transmission of the 5-124 is entirely pushbutton operated. Speeds can be changed while data is being recorded.
Write for Bulletin CEC 5124-X4.

Electro Mechanical Instrument Division CEC

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YOUR

New Catalogs GUIDE

131 HYDRAULIC MULTIPRESS

Denison Engrg. Div., American Brake Shoe Co.—Bulletin 324 describes the firms' new line of bench type hydraulic presses with capacities of from 1 to 12 tons. Data on special features and dimensions are given as well as available accessories and production advantages.

132 AIR-HYDRAULIC ACTUATOR

Electro-Mechano Co.—Bulletin describes hydraulic controlled air cylinder used for actuating many mechanical movements. The unit has a unique built-in valve arrangement which allows two different traverse rates throughout stroke. Cams can be set to determine points of rate change.

133 STEEL WIRE

American Chain & Cable Co., Page Steel & Wire Div.—A 16-page catalog, DH-1226, on Page shaped wire includes specification tables, range of sizes, physical properties of steel wire, table of standard wire gages, hardness conversion tables, with illustrations showing how to calculate areas of typical common shapes of wires. Size range includes cross-sectional area up to and including No. 3 BWG; flats and rectangles in widths up to 3/8 in., the ratio of width of thickness not exceeding 6 to 1.

134 STEAM GENERATOR

Mears-Kane-Ofeldt, Inc. Div., S. T. Johnson Co.—Bulletin 8-C covers new horizontal steam generator available in 6½, 15, 25, and 33 hp sizes for use with gas, oil, or combination gas or oil.

135 EQUI-POISED MOTOR UNIT

Falk Corp.—Bulletin 7100 includes the Equi-Poised Motor Mount to provide rigid mounting of motors from ½ to 30 hp. Mounts are fabricated of steel with provision for belt take-up.

136 AIR DIRECTIONAL VALVES

Westinghouse Air Brake Co., Industrial Products Div.—An eight-page catalog describes two-, three-, and four-way spool type directional valves with solenoid, lever, push button, pilot cylinder, cam, treadle, and pedal operators. Valves have tapped exhaust or open exhaust.

137 CENTRIFUGAL CASTINGS

Sandusky Foundry & Machine Co.—Bulletin No. 300 illustrates growing use of centrifugally cast cylinders in unfired pressure vessels, nuclear power, and other critical applications. Listed are typical ASME code-approved, ASTM, and military specifications for high-alloy, low-alloy, and carbon steels used in producing 14 recent applications. Specification minimum and actual physical properties given in comparative tables.

138 STORAGE WATER HEATERS

Patterson-Kelley Co.—Catalog 19 gives capacities and weights, dimensions, conversion tables, fixture capacities, material thicknesses, heating elements and construction details of storage hot water heaters.

139 GAGING APPLICATIONS

Sheffield Corp.—A 12-page booklet shows how column type Precisionaire gages are used to inspect single and multiple, internal and external demensions and other geometrical conditions and relations.

140 STEEL DECK GRANDSTANDS

Pittsburgh-Des Moines Steel Co.—Basic design of steel deck grandstands, their expansibility, proper seat spacing, and aisle widths are discussed in a four-page bulletin.

141 AIR HEATERS

Thermal Research & Engineering Corp.—A line of compact packaged direct-fired air heaters is described in Bulletin 112. These units may be fired with gas, distillate fuels or residual fuels or combinations of these fuels. The bulletin pictures typical arrangements including the various types of control equipment normally supplied. Typical sizes are shown for various combinations of flows and outlet temperatures.

YOUR

New Catalogs

GUIDE

142 POLY-V DRIVE

Raybestos-Manhattan, Inc., Manhattan Rubber Div.—Bulletin M141 illustrates and describes the firm's Poly-V drive, a power transmission system that uses only two cross sections instead of five standard V-belts. The unit is said to eliminate problems of matching belts because it is a single unit across the full width of sheave.

143 EXPANSION JOINTS

Marquette Coppersmithing Co.—An eight-page, illustrated release in tabular format on Omega metal bellows-type, expansion joints, covers allowable deflections and lengths of the Omega joint.

144 CEMENTED CARBIDE

Kennametal, Inc.—Form B-666, 24 pages, has photographs and descriptions of cemented hard carbide compositions, including compounds of tungsten, titanium, tantalum, columbium, and cobalt. Rolls, cylinder liners, floor tile dies, and seal rings are typical products.

145 SHAFT SEALS

Syntron Co.—First bulletin gives data on specifications of mechanical shaft seals for rotating pumps, turbines, compressors, engines and mixers. The second covers roll neck seals for back-up rolls in strip mills, tempering mills and other rolling mills, also internal seal parts and fluid couplings. The third covers face-type marine shaft seals featuring a split inflatable sealing ring.

146 PARALLEL-SHAFT SPEED REDUCERS

Link-Belt Co.—A 36-page book, 2719, describes line of "balanced design" parallel shaft reducers in 57 sizes, including 23 new sizes. Single, double, and triple reduction units are available in capacities up to 2800 hp at high or low output speeds, and ratios up to 292:1.

147 CERAMIC COATINGS

Norton Co.—Bulletins are available on Rokide ceramic coatings for protecting nozzles and exhaust chambers, combustion chambers, and other critical metal surfaces in missiles and space vehicles. Coatings are "A" aluminum oxide, "C" chrome oxide, "ZS" zirconium silicate, and "MA" magnesium aluminate.

148 HYDRAULIC CYLINDER

Tomkins-Johnson Co.—Bulletin SH-6-60 describes T-J high-pressure hydraulic square-head cylinder. Drawings and mounting dimensions are given for the different styles available. A table of maximum allowable push strokes is included.

149 FLUID HEAT TRANSFER UNITS

Hynes Electric Heating Co.—Bulletin 102.2 describes the pertinent design features and application of packaged electrically heated fluid heat transfer units. The unit includes the heater, circulating pump, instrumentation, piping and wiring completely assembled and ready for installation, available in ranges from 6 to 250 kw or larger, and in explosion-proof or dripproof construction.

150 PUNCHES AND DIES

T. H. Lewthwaite Machine Co.—A 28-page set of catalog sheets lists, illustrates, and cross-references the styles of punches and dies carried in stock. Charts and instructions are given for figuring correct clearance allowances between punches and dies for work being done. Illustrations and specifications of hand operated punches, cutters, and benders are included in the set.

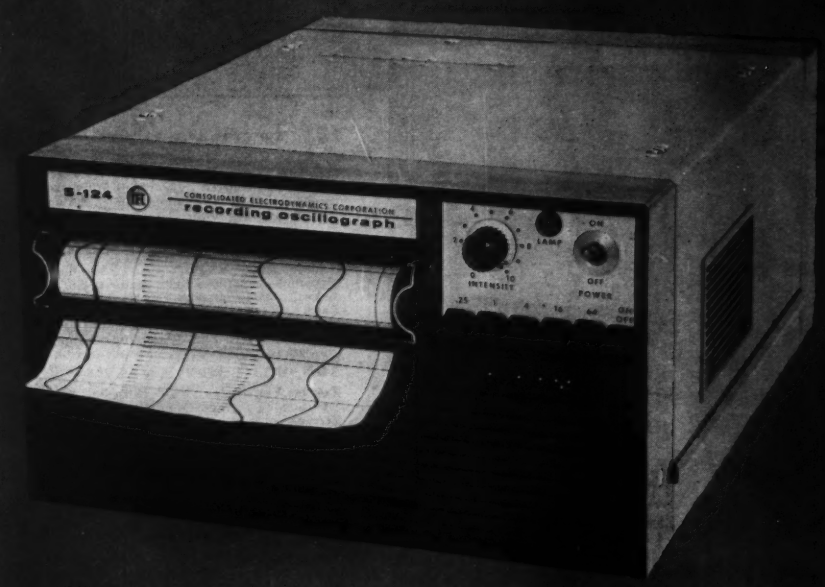
151 "CANNED" PUMPS

Goulds Pumps, Inc.—Four-page Bulletin No. 728.1 gives detailed specifications, ratings, dimensions on a new group of seal-less (canned) centrifugal pumps for handling volatile, toxic or inflammable liquids. Positively leakproof operation is claimed with capacities to 110 gpm and heads to 100 ft. Pumps are furnished in all ductile iron or 316 stainless construction.

152 PRESSURE LOSS TESTS

The Williams Gauge Co.—Pressure loss tests for a series of Williams-Hager silent check valves now are available. The tests, which were conducted by Cornell University, Department of Hydraulics, School of Civil Engineering, cover valves for pipe diameters ranging from 4 through 18 in.

read it!



NEW... HIGH WRITING SPEED OF 50,000 IPS...

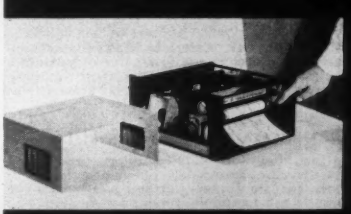
through an exceptionally efficient optical system. Record resolution of the highest order is assured with trace widths of 0.010" or better.

For even faster record access-time than afforded by the standard print-out process, there is the optional DATAFLASH unit, which speeds the print-out process by a factor of 60.

Check this list of standard and optional features. Only the CEC 5-124 can offer them.

STANDARD FEATURES
- 6, 12 or 18 channels
- 15" long x 13" wide x 7¾" high
- 115 volts, 50 or 60 cps, 500 watts
- 7" by 200' print-out record capacity
- High intensity mercury-vapor light source
- Intensity control
- Unexposed footage indicator
- Individual input connectors
- Automatically regulated galvanometer lamp circuit

OPTIONAL FEATURES
- Grid lines 1/10" or mm
- Trace identification
- Timing lines
- Galvanometer block heaters



Modular construction of the 5-124 allows fast, easy access to all internal components for servicing. Operates with the cover off, too, for dynamic testing.
Write for Bulletin CEC 5124-X4.

Electro Mechanical Instrument Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

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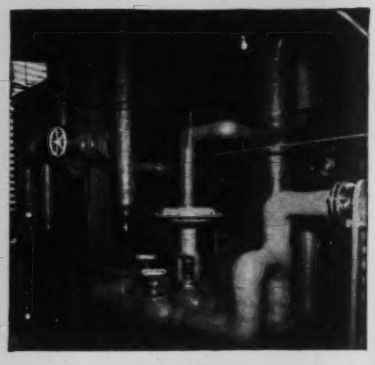
PRECISELY AS YOU NEED IT



NIAGARA CONTROLLED HUMIDITY AIR CONDITIONING

removes atmospheric moisture by direct contact with an absorbent liquid in a compact spray chamber. The spray contact temperature and the concentration of the absorbent liquid, two factors that are easily controlled, determine precisely how much moisture remains in the air leaving the unit.

This Niagara Controlled Humidity method, using Niagara Hygrol Absorbent Liquid is....

The only really precise method of air conditioning because it removes moisture as a separate function from heating or cooling to give you assurance of accuracy of air moisture control.

It is the most reliable because the absorbent is continuously and automatically kept at the proper concentration. No moisture-sensitive instruments are required to control your conditions.

It is the most flexible because with it you can either hold the precise condition you need as long as you wish or vary it with accuracy.

It is easiest to operate and maintain because the equipment and controls are simple and trustworthy.

This method is successfully used in the storage, testing and production of hygroscopic materials, in process control and as a pre-dehumidifier in comfort air conditioning.

Write for Bulletins Nos. 122 and 140.

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NIAGARA BLOWER COMPANY
405 Lexington Ave., New York 17, N. Y.
District Engineers in Principal Cities of U. S. and Canada

YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

153 AIR OPERATED CHUCKS

Cushman Chuck Co.—Catalog No. PO-66-1960, with companion price list, describes air operated chucks, rotating air cylinders, control valves, and accessories. It also includes typical installation and advantages of air chucking.

154 FABRICATION AND ERECTION

Graver Tank & Mfg. Co.—Four-page bulletin describes examples of the many products in steels and alloys furnished by Graver for heavy industry. Tank and process vessels for petroleum, chemicals, water, atomic energy, and missiles are among those described.

155 BOILER SERVICE VALVES

Everlasting Valve Co.—Bulletin describes the Everlasting Quick-Opening and Slow-Opening Straightway Valves, Angle Valves, Y-Valves, and Duplex Blow-Off Units, with specifications, materials of construction, and dimensions of each type. Illustrations include details of design, sectional and exploded views, and explanations of operation of the valves. The bulletin also describes Everlasting Valves for fire protection.

156 WATER DETECTION DEVICE

Ipsen Industries, Inc.—Bulletin WS-60 describes Water Sentinel, which detects water in concentration of 0.1 per cent or greater in enclosed type oil quench tanks or similar applications, triggering an alarm.

157 AERATORS FOR BULK STORAGE

Bin-Dicator Co.—Catalog describes and illustrates Bin-Flo, nonclogging air pads which use small volume low pressure air to restore flow characteristics to ground materials in storage. Dimensional drawings, mounting details, typical applications, list of users.

158 MEDIUM DATA PROCESSING SYSTEMS

Minneapolis-Honeywell Regulator Co.—Brochure describes specifications of Honeywell 400, a small magnetic tape data processing system. High-speed peripheral equipment plus efficient central processor are said to insure low unit costs for processing and maintaining files.

159 ELECTROMAGNETIC CLUTCHES

Stearns Electric Corp.,—Bulletin No. 226-J illustrates and describes line of electro-magnetic clutches, brakes, and combination clutchbrake units in large, small, and miniature sizes. Units with and without collector ring systems are shown. Torque ratings range from 25 in-oz to 180,000 lb-ft. Formulas are given to determine the size and type of clutch or brake for particular applications.

160 OPTICAL STRAIN GAGE

American Instrument Co.—Eight-page bulletin describes and illustrates the Aminco-Tuckerman optical strain gage that measures deformation and strain of materials subjected to stress at temperatures up to 1500 F. Measures tension and compression strains as small as 0.000002 in./in. on metals, brick, stone, concrete, plastic, many other materials. Bulletin 2294.

161 ABRASIVE SLURRY VALVE

United Conveyor Corp.—Bulletin No. 2V-60 describes newly developed valve for abrasive slurry applications. Valve can be installed in any position and has no slots or guides interfering with valve movement. Maintenance is said to be reduced to a minimum since there are no sliding metal to metal parts.

162 HYDRAULIC POWER

Denison Engrg. Div., American Brake Shoe Co.—Bulletin 220 describes the firm's line of hydraulic components including pumps, motors, pumping units, and controls. Operating characteristics of typical units are shown in tabular form.

163 MATERIALS HANDLING SYSTEMS

Allen-Sherman-Hoff Co.—Catalogs and data sheets describe Econo-Ash pneumatic handling systems for small coal-burning plants, Ashvac pneumatic ash handling systems for medium size plants, A-S-H hydraulic ash handling systems for utilities, and A-S-H pneumatic materials handling systems for various applications. Literature includes engineering charts and technical data, design, operation, and dimensions.

164 HOT WATER CONVERTERS

Patterson-Kelley Co.—Bulletin 303-A contains construction and operating data for hot water heating convertors. Tables show how to select proper convertors for such applications as industrial and domestic water heating.

165 MAGNETIC CLUTCH

Vickers Inc.—A Bulletin EPD-6106-5 on the new Vickers 10 lb-ft Magneclutch, a dry magnetic particle clutch, includes details on the construction and operational features of the clutch, dimensions and specifications, performance curves on heat dissipation and torque transmission, cutaway drawings illustrating the operating principles of the clutch, and other data.

166 ALLOY MECHANICAL TUBING

Babcock & Wilcox Co., Tubular Products Div.—Bulletin TB-430 is a primer on the use of alloy steel mechanical tubing. It describes structural, fabrication, and design advantages of tubing and gives tips on obtaining economies in the purchase of alloy steels in tube form.

167 DIESEL ENGINES

Nordberg Mfg. Co.—Power Chief four-cycle diesel and gas engines available in one, two, and three-cylinder units and a horsepower range of 8–54, for continuous duty or standby service, are described in 12-page Bulletin No. 239B. Power Chief diesel engine generator sets, available in all standard voltages, ac and dc, are also described.

168 CAST-IRON ECONOMIZERS

Green Fuel Economizer Co.—An eight-page bulletin describes both conventional and low-temperature applications of cast-iron economizers for new or replacement use. The corrosion resistance, ease of cleaning, and reduced draft loss of this heat transfer equipment is covered in detail.

169 VALVE CONVERSION UNIT

C. H. Wheeler Mfg. Co.—A new automatic valve actuating conversion unit is described in Catalog V-200. It is called Valvmatic and converts hand-operated valves to motor operation without removing the valve from line or disturbing piping. It is actuated electrically, and will open and close windows and operate valves.

170 ALUMINUM FABRICATION

Aluminum Co. of America—A 12-page booklet illustrates and describes the engineering, fabricating, welding, finishing, testing, and inspecting facilities at the firm's jobbing division.

171 BLAST CLEANING UNITS

Pangborn Corp.—Bulletin 705 describes new heavy duty Rotoblast barrels. Features and dimensions ranging from 20 to 102 cu ft capacities available for all production cleaning requirements. The Rotoblast wheel, throwing up to 60,000 lb of abrasive per hour, the abrasive reconditioning system, and other features are covered. Bulletin 706 describes standard-duty barrels and Bulletin 303A Rotoblast steel abrasions.

172 HIGH-STRENGTH STEELS

United States Steel Corp.—A 174-page manual discusses the essential principles of structural design and contains numerous formulas, charts and tables to assist in designing, for high-strength steels. The book covers engineering considerations and fundamental characteristics of high-strength steels, design considerations, working unit stresses, tension, compression, shear, stresses in beams, deformation and deflection.

173 CENTRIFUGAL, TURBINE PUMPS

Aurora Pump Div., New York Air Brake Co.—Four-page catalog provides condensed specifications and description of the firm's line of centrifugal and Apco turbine type pumps. Data includes applications for the various types of pumps ranging in capacities from 1 to 9000 gpm and pressures to 400 psi.

YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

174 WORM GEAR SPEED REDUCERS

Cleveland Worm & Gear Co.—Bulletin No. 410, 50 pages, provides complete engineering details on Cleveland's line of fan-cooled worm gear speed reducers. Units are claimed to be capable of transmitting up to 80 per cent more horsepower than that carried by conventional worm gear units and are available in single and double reduction types, the center sizes from 3 to 12 in.

175 RUBBER EXPANSION JOINTS

Raybestos-Manhattan, Inc., Manhattan Rubber Div.—Bulletin M685 describes a line of rubber expansion joints. Advantages and construction features are explained. Recommendations and a table of dimensions are provided.

176 MANUAL, SOLENOID VALVES

Barksdale Valves—Catalog 59-60 covers manual, foot-operated, and solenoid valves. Manual and foot-operated valves are 4-way, shut-off, manipulator, and dual pressure. Solenoid models include 4-way, 3-way, shut-off and diverter valve series.

177 STRAIN GAGES

Electronics & Instrumentation Div. Baldwin-Lima-Hamilton Corp.—Catalog covers 250 types of bonded filament resistance strain gages. Electrical and physical specifications of each gage type are included, together with prices and quantity discounts. A separate section provides data on the selection of gages.

178 WATER SOFTENERS

Permutit Co., Div. of Pfaudler Permutit Inc.—Bulletin 4696 contains information on high-capacity water-softening equipment. Details on operation, specifications, and performance are given. Model BD softeners are designed in four basic sizes.

179 PRECISION BORING

American Hollow Boring Co.—Sixteen-page brochure illustrates the firm's equipment, facilities, and operations in boring holes to specifications and precision testing. Data on hollow bored cylinders included.

180 VERTICAL SUCTION HEATER

Davis Engineering, Div. of American Metal Products Co.—Four-page bulletin describes and gives design and size capacity tables on new Paracoil type VUF vertical tank suction heater for installation in underground storage tanks. The heater is suspended from a tank manhole, with all service connections outside the tank.

181 VALVE OPERATORS

Ledeen Mfg. Co.—Bulletins illustrate and describe company's line of pneumatically or hydraulically operated valve operators for direct or remote control of gate, diaphragm and plug valves. Selection information, torque ratings, dimensions, and weights are given.

182 VARIABLE SPEED DRIVES

Sterling Electric Motors, Inc.—An 8-page bulletin illustrates and describes variable speed drives for metal working, mixing, pumping, materials handling and continuous processing. Engineering, selection and operating data is included.

183 REFRACTORY BRICK

Norton Co.—A 24-page booklet covers refractory brick and other fired shapes. Materials available, methods of manufacture, properties and characteristics, tables, graphs, and conversion charts are included.

184 THREADED INSERTS

Rosan, Inc.—Literature describes steel insert trademarked Inserto. External thread provides anti-rotational lock. Units, designed with an internal hex, available with internal threads No. 4 through 3/8 in. Internal thread lock optional.

185 AIR COMPRESSORS

Lincoln Engrg. Co.—Bulletin A-110 covers a new line of air compressors for automotive and industrial applications. More than 200 electric and gasoline driven models, ranging from 1/4 to 20 hp, are included.

186 TOOL STEEL

Crucible Steel Co. of America—Series of five booklets contains reproduction of presentations made before the firm's tool steel clinics. Data and discussion covers virtually every phase of application, selection, manufacturing of various steels.

187 DUST, FUME COLLECTORS

Northern Blower Co.—Bulletin 164 describes automatic bag type arresters, diagrams standard dimension factors and supplies table of dimensions and capacities. Separate additional bulletins contain similar data for standard bag type (not automatic), hydraulic type, centrifugal type, and portable dust collectors.

188 CONSTANT TEMPERATURE PUMPS

Dean Brothers Pumps Inc.—Circular 195 describes new line of standard constant temperature pumps, Types CT-C and CT-R for maintaining processes temperatures when pumping of liquids which congeal, solidify or crystallize with loss of heat. Sectional views illustrate two methods of applying heat to pump: tracing and jacketing.

189 GAGES AND THERMOMETERS

Marsh Instrument Co.—Catalogs No. 76-G and 76-T describe in detail a wide line of industrial gages, needle valves, and thermometers. The catalogs are fully illustrated, including cut-away photographs and enlargements of internal parts. They cover also gage accessories, specifications including line drawings and dimensional tables, and templates covering every size and pattern.

190 RECORDING SYSTEMS

Consolidated Electrodynamics Corp.—Technical bulletins covering Data Tape magnetic-tape recording and playback systems furnish descriptions and specifications for airborne and ground-based components and accessories. Ground system is described in Bulletin Nos. 1576, 1608, 1613, and 1615. Airborne components are covered in Bulletin Nos. 1592-5, 1578, and 1607.

191 WELL SCREEN

Layne & Bowler, Inc.—Bulletin 900 covers improved Model 134 shutter screen for gravel wall wells. Specifications are included.

192 PISTON, SEALING RINGS

Koppers Co., Metal Products Div.—A 24-page brochure illustrates and describes American Hammered piston and sealing rings for various types of industrial applications. Also available are four-page folders on conformable oil ring, marine piston rings, chrome-plated piston rings, piston rings for air and steam forging hammers, Teflon rings, railroad piston rings, and an eight-page brochure on metallic sealing rings.

193 FIRE PUMPS, FITTINGS

Peerless Pump Div., Food Machinery & Chemical Corp.—A 32-page bulletin, No. B-1500, describes, illustrates, and tabulates, with dimensional data, hundreds of models of Underwriters approved horizontal and vertical centrifugal fire pumps, fittings, and drivers for application to commercial and industrial risks. Addendum includes selection charts with data for each model.

194 FOUNDRY CUPOLA BLOWERS

Roots-Connersville Blower, Div. of Dresser Industries, Inc.—Bulletin FC-158 covers all FEMA listed standard sizes of iron cupolas. It gives the manufacturer's optional recommendations for suitable air blowers of either positive displacement or centrifugal type. Performance data is provided for all units at representative operating conditions. Automatic control systems for constant air weight are described and illustrated.

195 DEMINERALIZING

Cochrane Corp.—A 40-page "Handbook on Demineralizing" compares various methods of water treatment, and demineralizers and evaporators. Characteristics of various types of cation and anion exchange materials are discussed and data on operating costs is included.

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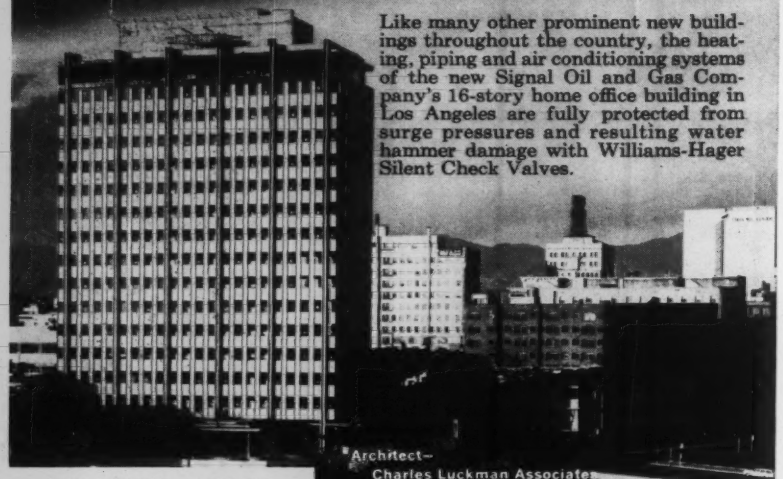

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196 SLIDING GATE CONTROL VALVES

OPW-Jordan Corp.—Eight-page Catalog J170-1 describes sliding gate control valves in sizes from 1/4 to 6 in. Benefits of sliding gate construction are explained. Illustrated catalog includes features, cutaways, applications, sizing, controllers, and positioners.

197 AUTOMATIC TAPE ANALYZER

Graver Water Conditioning Co.—Bulletin WC-127 describes the Graver automatic tape analyzer, an instrument for measuring trace quantities of insoluble solids in liquids. The analyzer employs ultra-filtration techniques, an automation of the Millipore filter test, and is sensitive to 2–4 ppb solids. It can repeat its sampling and testing cycle as often as once every minute, day and night, and is completely automatic. Test results may be stored for future reference.

198 HOT WATER BOILERS

Combustion Engineering, Inc.—20-page brochure describes and illustrates the design, construction, advantages, and economies of the La Mont controlled circulation hot water boiler for supplying high pressure, high temperature water for heating systems and process applications.

199 VIBRATION INDUCERS

Martin Engrg. Co.—A 38-page catalog gives engineering data, specifications, and price list on the Vibrolator line of vibration inducers, listing 52 sizes and types from the BD-10 (4 1/2 oz) to the 3000 lb impact CCVP series hopper car shaker (72 lb.). Units are available in pneumatic, electric, gasoline, hydraulic, and steam.

200 AUTOMATIC PRESSURE CONTROLS

A. W. Cash Valve Mfg. Corp.—An 84-page catalog offers information on relief valves, safety devices, pressure regulators, hydronic heating valves, refrigeration controls, and protective equipment. The catalog contains capacity and spring range charts, installation, and engineering information.

201 TRANSDUCERS

Pace Engineering Co.—Catalog describes a line of magnetic reluctance pressure transducers, including d-c output types with self-contained carrier-demodulator, and provides detailed performance specifications. Typical associated equipment and recording systems are described.

202 PACKAGED LIQUID CHILLER

American-Standard, Industrial Div. — Bulletin 3926 describes series of Versare hermetic packaged liquid chillers. Eleven models provide small capacity increments up to a nominal 60 tons. Features include compact hermetic construction, complete controls with eight pilot lights indicating normal operation or cause of emergency shutdown, and protective base.

203 GASKETS METAL RASCHIG RINGS

Metallo Gasket Co.—Bulletin No. 57 describes metal and metal combined with soft packing for use on high and low pressure service, metal tower packing made as Raschig and Lessig rings. Also washers, shims, and metal asbestos valve disks.

204 WELD TUBE MILLS

Yoder Co.—A 64-page handbook describes the use of modern tube mills in the manufacture of pipe and tube. A description of the electric-weld process and photos, drawings and charts on the operation, capacities, and applications of various mills are included.

205 SCREW CONVEYOR DRIVE

Falk Corp.—Bulletin 7106 describes new drive designed especially for screw conveyors. Six unit sizes, each with four ratios, bolt to any standard trough end. Choice of seal housings are designed to assure protection between unit and any conveyed material. Optional trough end and pre-drilled motor mount are available for any size unit from 1/2 to 30 hp.

206 CONSTRUCTION ALLOY STEEL

United States Steel Corp.—Form ADUCO-01060L, 64-pages, gives information on fabrication, engineering data, and metallurgical characteristics of T-1 constructional alloy steel. Case histories of applications are included.

207 AUTOMATIC DATA SYSTEMS

Hagan Chemicals & Controls, Inc.—Bulletin MSP 161 describes Kybernetes automatic data processing systems. The electronic equipment logs, monitors, computes any number of input variables at 0.1 per cent overall full scale accuracy. Bulletin includes basic design parameters and technical description of various stages of the equipment.

208 LUBRICANTS, COMPOUNDS

Shell Oil Co.—A series of folders gives data on properties, testing, applications of a new atomic power lubricating grease, an extreme temperature range lubricant or missile applications, an emulsion-type lubricant for large low-speed diesel engines, compounds and fluids for open gears under extreme pressure loads, and the company's oil-print analysis for field diagnosis of motor oils.

209 VARIABLE SPEED DRIVE

Cleveland Worm & Gear Co.—Bulletin K-200, eight pages, describes the operation and construction and provides application data for the Cleveland speed variator. Made in sizes from fractional to 15 hp, this mechanical traction drive is said to be slip free and infinitely variable over a 9:1 speed range, and is available with various controls for remote or automatic operation

210 CLAD STEEL EQUIPMENT

L. O. Koven & Bro., Inc.—A booklet gives data on the development of properties, types, testing, design considerations, fabrication, and applications of clad steels. Another booklet covers cleaning, maintenance of clad steel equipment.

211 SURFACE CONDENSERS

Worthington Corp.—Bulletin W-200-B3A shows applications of surface condensers for steam power stations, industrial processes, marine and water works service.

212 MAGNETIC FLOW METERS

Foxboro Co.—Bulletin 20-14C describes two new magnetic flow meters for different flows. Developed for 1/10 and 3/16-in. lines, they measure full scale flow rates as low as 0.1 gpm, and are said to be useful in ratio flow control and pilot plant applications. Bulletin includes specifications and instrument data.

213 VIBRATING GRATE STOKER

American Engineering Co.—Literature describes a water cooled vibrating grate stoker in sizes from 25,000 to 150,000 lb of steam per hour. The unit does not require a dust collector and is said to burn low grade coals with efficiency or can be adapted for burning gas or oil in combination with coal or singly.

214 SPIRAL CONVEYOR

Jeffrey Mfg. Co.—Catalog 951,56 pages, includes engineering data, conveyor layouts, specifying information, specifications, drives, capacity tables, feeders, hangers, troughs. Charts, drawings, photographs support detailed description.

215 OPTICAL PARTS

Bausch & Lomb—A 16-page catalog of optical parts contains information on ground glass, heat absorbing glass, retardation plates, and the firm's precision glass engraving and optical coating services. A new price list detailing up-to-date individual part prices, discount procedures is included. Catalog L-117.

216 COPPER TUBING HANGERS

Grinnell Co.—A 12-page catalog, CTH-56, covers hangers and supports for copper tubing. All hangers are copper plated and accurately sized to fit standard copper tubing. Data is also included on packaged quantities.

217 GAS FIRING EQUIPMENT

Iron Fireman Mfg. Co.—Form 6260 is a general catalog of commercial and industrial gas, oil, and coal firing equipment. Basic considerations are discussed and an index and selection chart is included. Oil burners, gas burners, and dual fuel burners are covered, together with coal stokers.

218 HIGH PRESSURE NEEDLE VALVES

Dragon Engineering Co.—Catalog shows a complete line of needle valves, globe and angle types. Sizes are from 1/8 to 1 in. with pipe or tubing connections. Also covered are remote control diaphragm valves, gage glass fittings, and special valves.

YOUR

New Catalogs

GUIDE

219 FLEXIBLE BALL JOINTS

Barco Mfg. Co.—Bulletin 31 illustrates the use of flexible ball joints for pipe connections when thermal expansion or contraction or both create piping problems. Line drawings, dimension tables, and photographs are included in this eight-page bulletin to describe basic piping arrangements adaptable to almost any piping application.

220 PACKINGS

Johns-Manville—A 12-page brochure, PK-17A, contains a packings selection chart of rod, plunger, and valve stem packings; illustrations and descriptions of precision rings, hydraulic and groove packings, oil seals, metallic and cut gaskets.

221 SUPER REFRACTORIES

Carborundum Co., Refractories Div.—"Properties of Super Refractories," twenty-four pages, covers latest data on super refractories including newly developed compositions for specialized applications. Re-frax silicon-nitride bonded silicon carbide refractories which can be produced in intricately designed shapes to close dimensional tolerances is described. Chemical analysis and physical property charts are provided on all materials.

222 SEAMLESS WELDING FITTINGS

Babcock & Wilcox Co., Tubular Products Div.—FB 502 A is an eight-page brochure covering carbon, alloy, and stainless steel seamless welding fittings and flanges. It contains charts of standard sizes and schedules according to ASA B36.10 and ASA B36.19. Bulletin illustrates fittings and flanges commonly produced, and lists sizes and types available.

223 PACKAGE WATER TUBE BOILER

E. Keeler Co.—A 10-page catalog on water tube package boilers contains illustrations and data on a unit available in capacity range of 6000 to 60,000 lb-steam per hour.

224 PUMPS AND VALVES

Denison Engineering Co., American Brake Shoe Co.—Pumps and valves for the aircraft and missile fields are described in this bulletin. Fluid motors, pump motors, and pumps, both axial piston and vane type, are included. Check valves, surge damping valves, pressure control valves, and other types are covered.

225 STRUCTURAL HANDBOOK

Aluminum Co. of America—Revised handbook supplies design information on the use of aluminum in structures. New edition has 420 pages including 140 tables.

226 STRUCTURAL INSULATING PANELS

Philip Carey Mfg. Co.—Form No. 6301 provides data on a rigid, structural material that also insulates walls, roof decks, partitions. It is made by bonding asbestos-cement board to both sides of a specially processed asphalt-treated insulation board. The material is described as lightweight, water-resistant, approximately 60 per cent light reflectivity, won't rust nor rot and needs no preservative treatment or painting.

227 DRAFTING MACHINE

Universal Drafting Machine Corp.—Tracmaster, a drafting machine for large size work which features automatic board tilt, is described. The unit has beam-rails that require no initial alignment or subsequent adjustment for straightness. Engine-divided graduations on each rail divide, in effect, the drawing area into a 10-in. grid pattern.

228 FOUR-CYCLE V-ENGINES

Nordberg Mfg. Co.—Four-cycle V-type engines are described in an 18-page Bulletin No. 262. Examples are shown of the significant advancements in diesel engine performance for V-type engines that are supercharged, supercharged and intercooled, and Supairthermal.

229 TEMPERATURE CONTROLS

Fenwal Inc.—Detailed folders describe devices for temperature detection, indication and control. Included are Thermoswitch and snap action local controls, remote bulb and capillary units, Detect-a-Fire and electronic thermistor controllers.

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230 PUMPS, SEPARATORS

Kraissl Co.—Revised Bulletin A1803 gives information on air compressors, vacuum pumps, rotary positive displacement liquid pumps, separators, strainers, filters. The firm's Class 60 series pumps, both direct and reduction drive models, are UL listed.

231 COUNTING DEVICES

Veeder-Root, Inc.—Modern mechanical electrical, and electronic counters for all industrial and special counting requirements are briefly described in a four-page condensed general catalog. Also contains information on applications and how-to-order.

232 DRUM STEAM GENERATORS

Erie City Iron Wks—Catalog SB61, 16 pages, illustrates by cross section and wash drawing both open pass and multi-pass 2-drum steam generators and auxiliaries. Examples of pressurized and balanced draft multi-pass installations are shown. Details of design and construction for steam separators, superheaters, economizers, air preheaters, and water walls are included.

233 TUBE EXPANDERS

Gustav Wiedeke Co.—Catalog 81 contains specifications on the firm's line of tube expanders and cutters. Included are tables of sizes, ordering information and a list of domestic and foreign distributor locations.

234 LUBRICATION RECOMMENDATIONS

Shell Oil Co.—A bulletin gives detailed lubrication recommendations for contractors' equipment, including gearing, wire ropes, pneumatic tools, power steering, etc. Another bulletin illustrates and describes the company's Rotella T oil, a heavy duty motor oil for truck fleet operators.

235 WORM GEARING

Cone-Drive Gears Div., Michigan Tool Co.—Literature covers double-enveloping worm gearing supplied in standardized gear sets of 9 ratios on 15 different center distances from 2–24 in. available as gear sets and in complete speed reducers. The same ratios are supplied in 8-center distances in gearmotors. All sizes of gearmotors and standard speed reducers from 2–3½ in. are available with hollow shafts.

236 PROPELLER, MIXED FLOW PUMPS

Layne & Bowler, Inc.—Bulletin 350 includes propeller and mixed flow pumps with cut-away application photos and performance charts.

237 DATA PROCESSING

Consolidated Electrodynamics Corp.—Technical bulletins describe MicroSADIC analog-to-digital conversion equipment, recording oscillographs, amplifying systems, and direct-writing oscillographs. Operating information and description of applications are also included. Bulletin Nos. 3004, 1585A, 1536B, 1500D, 1598B, 1522D, and 1589 are offered.

238 O-RINGS

National Seal Div., Federal-Mogul-Bower Bearings, Inc.—This National O-ring catalog is designed for broadest usefulness in all types of O-ring applications. Includes practical working information about O-ring applications, sizes, groove dimensions, back-up rings, and dust seals, and lists all National O-rings and local National Seal Division offices.

239 SPEED REDUCERS

Farrel-Birmingham Co.—Bulletin No. 450-A, "Farrel Speed Reducers," illustrated 52-page booklet contains full information about speed reducers. Included are horsepower rating table, specifications, dimensions, weights, and other data required for quick selection of speed reducers for various applications.

240 UNDERDRAINS FOR SAND FILTERS

Graver Water Conditioning Co.—Bulletin M-100 illustrates Graver Corru-Drain, a patented underdrain design for rapid sand filters. Constructed of multiple corrugated asbestos-cement sheets, Corru-Drain provides a noncorrosive underdrain which is claimed structurally strong, light in weight, and precision fabricated in sections.

241 RAILROAD CAR SHAKER

Webster Mfg. Inc.—Bulletin 60D illustrates and describes the car shaker, a cradle type unit weighing 3600 lb and powered by 10-hp motor. The shaker is capable of unloading coal, stone, gravel from hoppered bottom cars.

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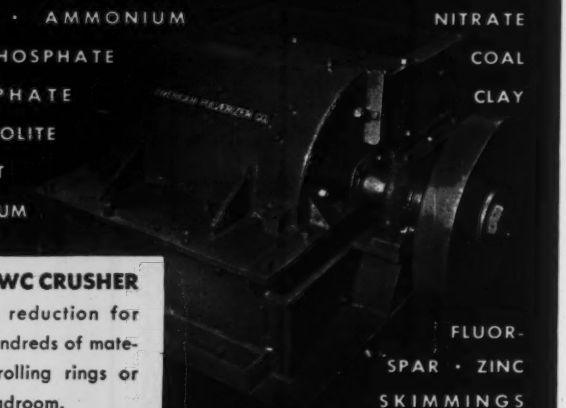

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242 BALL-BEARING SWIVEL JOINTS

Chiksan Co.—General Catalog G-5 covers the company's complete line of ball-bearing swivel joints, loading arms and flexible assemblies. Included are information on how to use swivel joints, applications, and dimensional and operating data.

243 AIR-HYDRAULIC PUMPS

Ledeen Mfg. Co.—Bulletin 4001 describes air-hydraulic pumps and power units for developing high pressures with relatively small volumes. Air or gas may be used as the prime mover, while hydraulic cylinders can be supplied for oil or water service. Units consist of a reciprocating low-pressure pneumatic cylinder actuating two high-pressure hydraulic cylinders.

244 CYLINDERS, CONTROLS

Westinghouse Air Brake Co., Industrial Products Div.—Three bulletins are offered. F9-180.00 covers basic pneumatic air controls; DO-OO-2 lists catalogs covering the division's line of products; D3-41.01 describes double acting, cushioned and non-cushioned streamlined cylinders.

245 OIL AND GAS BURNERS

Ray Burner Co.—A new illustrated 16-page catalog gives specifications and capacities of commercial and industrial gas, oil, and combination gas-oil burners. It covers fully automatic, semi-automatic, and manually controlled horizontal rotary oil burners, gas burners, and combination gas-oil burners; commercial and domestic pressure-atomizing types for oil, gas, or combination gas-oil inshot gas burners; forced draft package burners. Tables and other technical data.

246 REDUCERS, GEARMOTORS

D. O. James Gear Mfg. Co.—Four catalogs illustrate and describe the firm's gear-motors and speed reducers. Catalog 40-E-continuous-tooth herringbone gear speed reducers; 46-F-right angle gearmotors and motoreducers; 47-PE-planetary in-line reducers; 47-ME-in-line gearmotors and reducers.

247 SPECIAL SERVICE HOSE

Raybestos-Manhattan, Inc.—Manhattan Rubber Div.—Catalog M680 gives information on features, construction sizes, fittings and materials used in special service hose. Application photos show the hose in use in various industries.

248 PRESSURE GAGES

American Chain & Cable Co., Helicoid Gage Div.—The 24-page Helicoid gage catalog describes the Helicoid gage as guaranteed accurate to within 1/2 of 1 per cent of the total dial graduation over the upper 95 per cent of the 270-deg dial arc. Cutaway photographs and line drawings show the complete line of Helicoid gages.

249 CUSHIONED AUTOMATIC VALVES

Golden Anderson Valve Specialty Co.—A comprehensive catalog of technical bulletins in a loose-leaf ring binder covers the firm's line of special cushioned automatic valves. Included are swing check valves, surge relief valves, water reducing valves, altitude control valves, float valves, liquid strainers, solenoid operated valves, control valves, electric check valves, triple-acting nonreturn valves, engine stop valves.

250 BUCKET ELEVATORS

Jeffrey Mfg. Co.—Catalog 950, 96 pages, covers all aspects of materials-handling elevator equipment. It introduces special cement mill elevator, and contains drawings, diagrams, specification charts, installation photographs.

251 BRONZE BEARINGS

Bunting Brass & Bronze Co.—Catalog 258 lists 343 stock sizes of cast bronze electric motor bearings for all makes and sizes of electric motors. These are made exactly to dimensions of original equipment and fit without further finishing.

252 COPPER DRAINAGE TUBE

Chase Brass & Copper Co.—Publication G-23, 30 pages, tells the story of the economy of copper tube and solder-joint fittings for soil, waste, and vent lines, gives roughing-in dimensions for drainage fittings.

253 SNAP ACTION SWITCHES

Minneapolis-Honeywell Regulator Co., Micro Switch Div.—The 24-page Catalog No. 101 covers representative line of precision snap-action and mercury switches. It includes data on high temperature, maintained-contact, explosion-proof, high capacity, proximity, oil-tight, environment-free and multi-curcuit types. It has photographs, dimensions, electrical ratings, characteristics and application information.

254 CYLINDER PACKINGS

E. F. Houghton & Co.—Catalog describes Rex-Syn cup packings made of plastic resin and elastomer. The catalog also gives sizes and results of several field tests.

255 LOCK WASHERS

Illinois Tool Works, Shakeproof Div.—"This Washer Locks" is an eight-page book that shows the features of Shakeproof lock washers and contains schematic drawings, charts, and photos showing problem applications. In addition to product descriptions, a number of actual examples of use are illustrated.

256 STRIP CHART CODE PRINTER

Royson Engineering Co.—Identicharts RI-3 and 3A print a remotely selected code number or letter on the chart of a strip chart recorder and have 12 or 24 position print wheels for engraving with codes to customers' orders. They are illustrated and described in Bulletin 130. The units, available in installation kits for most recorders, mount on the door, and are said not to interfere with the normal operation of the recorder.

257 CONTROL VALVE

Graver Water Conditioning Co.—Bulletin WC-122 examines the Graver Monotrol valve, a single control valve designed to perform the functions of a nest of valves controlling the flow of liquid in zeolite softeners, ion exchange units, and filters. It features simple pilot operation, positive water actuation, and provision for low pressure loss and no leakage, with automatic or manual operation.

258 ELECTRIC SWITCHES

Cherry Electrical Products Corp.—A 16-page, three-color catalog covers the line of precision, snap-action Cherry switches including light force, miniature, enclosed and open switches. Each switch type is dimensioned by an engineering drawing, all operating characteristics are listed and the many variations of each type are illustrated.

259 IMPLEMENT BALL BEARINGS

New Departure Div., General Motors Corp.—A booklet illustrates and describes ball bearings for use on farm implements. The 24-page booklet has cutaway photos, drawings, dimension, load rating tables for a variety of farm applications.

260 STAINLESS STEELS

G. O. Carlson, Inc.—A 12-page, illustrated bulletin, "Producing Stainless Steels...Exclusively," details typical applications of materials in metalworking, chemical process, nuclear, aircraft and missile industries. A table shows the standard and superior types of stainless steel plate that are in mill inventory or available on order. Basic production limits in manufacturing stainless steel plates, heads, forgings, rings, circles, and flanges are included.

261 WATER, SEWAGE EQUIPMENT

Link-Belt Co.—Book 2617, 20 pages, contains illustrations and photographs of the latest sanitary engineering equipment and also shows flow diagrams of how this equipment can be installed in typical water, sewage, and industrial waste treatment plants.

262 FLOW TUBE

B-I-F Industries, Inc., Builders-Providence Div.—Weldment dall flow tube is described in Bulletin 0115.20-3. Combined advantages of power savings from low head loss, maximum accuracy and short laying length are claimed.

263 GRAVITY SEPARATOR

Graver Water Conditioning Co.—Bulletin WC-123 describes the operation and features of the Graver Rota-Rake clarifier, a horizontal flow sedimentation and thickening unit for the separation of suspended solids from liquids by gravity. Designed for maximum separation, positive sludge removal, and complete overload protection, the Rota-Rake is available with round or square tank and a variety of drives.

Fill in and Mail the coupon on page 152 without delay.

YOUR

New Catalogs GUIDE

264 POWER LUBRICATION

Lincoln Engrg. Co.—Eight-page brochure describes and illustrates the latest development in power operated lubrication systems, both automatically (full and semi-) and manually timed. These systems are designed for application on existing facilities or original equipment.

265 PLASTIC PIPE FITTINGS

Grinnell Co.—A 16-page catalog on corrosion resistant pipe fittings, flanges, valves and pipe in normal impact grade and high impact grade, rigid, unplasticized polyvinyl chloride shows characteristics, advantages and limitations. Listed are operating pressures, temperatures, applications, price comparisons, fabrication advice, installation and supporting recommendations, dimensions and weights.

266 PROCESSING EQUIPMENT

Patterson-Kelley Co.—Bulletin 16 contains product discription and specifications on the firm's line of blenders, vacuum tumble dryers, packaged resin-distillation pilot plants, and process heat exchangers. The bulletin also describes the organization and operation of the company's Pre-Test laboratory which, in testing customer formulations, helps determine proper blending equipment and correct blending procedures.

267 FANS

Buffalo Forge Co.—Bulletin F-104A gives information on single and double inlet Type BL limit load fans. It includes the range of sizes and capacities and points up special features of design, construction, and performance.

268 DIESEL, DUAFUEL ENGINES

Nordberg Mfg. Co.—A 16-page bulletin describes two-cycle, 21-in. bore, diesel, and Duafuel engines for stationary and marine service. The bulletin, No. 245, describes operating advantages of the Series 21 engine and includes views of utility, industrial power, and marine installations.

269 CAMS

Ferguson Machine Corp.—Catalog No. 902 discusses cam design theory. Selection tables and selection graphs are presented for standard and semi-standard cams. Barrell cams are included as well as plate and face types.

270 LIFT TRUCK SCALE MODELS

Materials Handling Div., Yale & Towne Mfg. Co.—Three-dimensional plastic or metal models and two-dimensional templates (1/4 in. scale) are offered for this firm's entire industrial lift truck line as visual aids for planning with plant mock-ups or scale drawings.

271 HIGH-TEMPERATURE-WATER GENERATORS

Babcock & Wilcox Co.—A 36-page Bulletin G-92 describes and illustrates high-temperature water systems for process and space heating in large plants, institutions, commercial and residential buildings. The bulletin also covers forced circulation generators and standard steam package boilers for high temperature water systems, and new technical data on high-temperature water.

272 STROBOSCOPE

General Radio Co.—A new white-light Strobotac stroboscopic tachometer is described in detail in six-page bulletin. The Strobotac is claimed not only to make the measurement of speed a simple operation, but also allows observation of operating machine parts in apparent slow motion. Many applications are illustrated.

273 HEAT EXCHANGER TUBES

Aluminum Co. of America—Illustrated catalog contains relevant data of Alcoa aluminum heat exchanger tubes. Covers advantages, fabrication, application in petroleum and petrochemical industries, chemical, steam, atmospheric, air and gas. Also use of aluminum alloys, fluid flow characteristics, heat transfer characteristics, resistance to corrosion specifications and data with tables. Form 10186.

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274 HYDRAULIC PULSATION DAMPENER

Westinghouse Air Brake Co., Industrial Products Div.—A four-page catalog illustrates and describes a device that suppresses the pulsations and pressure surges which reciprocating pumps, centrifugal pumps and quick closing valves introduce into hydraulic systems.

275 CENTRALIZED LUBRICATION

Cleveland Worm & Gear Co.—A 24-page revised general Bulletin No. 26-T describes the complete line of Farval centralized lubricating systems. Principles of operation, system components, and product advantages are discussed, and typical applications are illustrated.

276 AFTERCOOLERS AND SEPARATORS

R. P. Adams Co.—Bulletin 714 describes in detail design, applications, and operation of aftercoolers and cyclone separators for compressed air and gases. It contains typical installation photographs and tables for determining the type and size for particular situations.

277 INDUSTRIAL COOLING FANS

Koppers Company, Inc., Metal Products Div.—A 4-page folder illustrates and describes new, all-metal, "Precision-Engineered" Aeromaster fans for cooling towers and radiator-type coolers. Design features are discussed.

278 SPHERICAL ROLLER BEARINGS

The Torrington Co., Bantam Bearing Div.—Catalog 258 describes line of self-aligning spherical roller bearings. Dimensional data is given along with information on design, manufacture, packaging, and locknuts, lockwashers, and sleeves. A section is included on engineering for roller bearings.

279 NONFERROUS CENTRIFUGAL CASTINGS

Shenango Furnace Co., Centrifugal Cast Products Div.—Flyer shows samples of centrifugally cast nonferrous products. A table lists different alloys available, with comparative specifications, nominal chemical analyses, and minimum physical properties.

280 AIR AND GAS COMPRESSORS

Norwalk Co.—Catalog 1960 describes the integrated facilities in engineering, production, and testing that custom-produce Norwalk compressors from single stage to six stages, from 0 to 42,000 psi pressures for a full range of gases and air.

281 HYDRAULIC PRODUCTS

Vickers, Inc., Div. of Sperry-Rand Corp.—Catalog 5001C includes: power packages, servo valves and systems, vane pumps, piston pumps, pressure controls, flow controls, directional controls, control assemblies, hydraulic motors, variable speed drives, hydraulic cylinders, and accessories. Photographs, drawings, tables, curves, and typical circuit diagrams are included.

282 CONVEYER BELTS FOR 45 DEG IDLERS

Raybestos-Manhattan, Inc., Manhattan Rubber Div.—A 12-page brochure, No. M303, illustrates and describes heavy duty conveyer belt specially designed for operating over 45 deg idlers. It is claimed that savings up to 20 per cent conveyer costs and 12 to 60 per cent greater hauling capacity is possible with this belt. Advantages are discussed.

283 LIQUID PULSATION DAMPENER

Pulsation Controls Corp.—Literature discusses the design parameters, performance, and construction of the pulsation dampener. The unit has no moving parts, and is said to be especially suited for high speed plunger pumps. Sizing charts are included. The unit is also applicable as an acoustic filter for attenuation of audible noise originated by centrifugal and positive displacement pumps.

284 ALUMINUM HANDBOOK

Aluminum Co. of America—A hard cover book contains data on aluminum alloys and mill products in tubular form. Information is given as reference for those responsible for planning, designing, testing, purchasing, and fabricating aluminum successfully. Form 10051.

285 AIR CYLINDER

Tomkins-Johnson Co.—Bulletin SQ-3-60, 16 pages, covers T-J square-head air cylinders. Mounting dimensions are given for different styles. Bulletin includes tables for maximum allowable strokes.

Requests limited to 25 catalogs. (Sorry, no catalog distribution can be made to Students.)

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286 VIBRATION AND NOISE CONTROL

Lord Mfg. Co.—Bulletin No. 905 lists products designed to reduce vibration, shock, and noise. Different types of mountings, joints, panels, structural sections, mounting systems, and suspensions are covered.

287 PACKAGE DEMINERALIZERS

Permutit Co., Div. of Pfaudler Permutit Inc.—Bulletin 4721 describes standard packaged demineralizers, factory-assembled, with systems ready to connect and operate. Summary of applications, plus data on mixed-bed, two-step, non-regenerable, and skid-mounted units, are included.

288 GAS FIRED FRESH AIR SUPPLY HEATERS

L. J. Wing Mfg. Co.—Bulletin GFAS-60 describes Wing direct gas fired fresh air supply heaters of unitized construction, factory pre-wired and piped ready for installation. They are made in five sizes suited for wall or roof inlet and offer up to 50,000 cfm and 4,500,000 Btu per hr output.

289 INSTRUMENT BALL BEARINGS

New Departure Div., General Motors Corp.—A 36-page booklet illustrates and describes ball bearings for use in precision instruments. Tables, charts, and diagrams show the various series of miniature bearings in a wide range of applications.

290 PROCESS INDUSTRIES CONTROLS

Swartwout Co.—Bulletin A-913, "A Functional Guide to Swartwout Autronic Control Equipment" describes electronic control line instrumentation for chemical processing, power generating, and related process industries and offers a guide for applying instrument components for the total system design.

291 HIGH TEMPERATURE WATER PUMPS

Dean Brothers Pumps Inc.—Circular 214 describes the firm's line of standard centrifugal pumps for high temperature water systems used for large volume space heating and for industrial process heating. Pumps for boiler and system circulating and for boiler water make-up are illustrated. Pump data and stuffing box sealing information are also included.

292 VALVES, CONTROLS

Hays Mfg. Co.—A packet of data sheets covers the firm's lines of solenoid valves, controls, strainers and automatic interlocks. Specifications, dimensions and flow charts are given.

293 INDUSTRIAL EQUIPMENT

Allis-Chalmers Mfg. Co.—Booklet 25B6057A makes reference from A to Z to literature available on the wide variety of products produced by the company. Capital goods equipment for almost every industry, in addition to construction and agricultural equipment, is covered, ranging from absorption machinery to zeolite softeners.

294 ASH SLUICING SYSTEM

United Conveyor Corp.—A four-page Bulletin No. 1S-57 describes recirculating closed circuit ash sluicing system with description of principle and sequence of operation.

295 PRESSURE VESSELS

Koven Fabricators, Inc., Div. of L. O. Koven & Brother, Inc.—Bulletin No. 550 illustrates and describes mixers, kettles, vacuum and pressure vessels, autoclaves, evaporators, impregnators condensers, stills, extractors, tanks, standpipes, piping, stacks.

296 HEAT EXCHANGERS

American-Standard Industrial Div.—Bulletin 1.1K6 describes expanded, redesigned line of standardized, pre-engineered Type BCF exchangers. New features include baffles with flanged lip at tube holes and outer edge for improved thermal characteristics; movable feet; corrosion resistant copper alloy core assembly; and cast iron bonnets. Specifications detail 46 stocked sizes in one, two and four-pass designs.

297 AIR DRYER

Hankison Corp.—Detailed information about Series-E air dryer is provided in Bulletin No. 9300. The illustrated bulletin shows how the unit operates, and includes specifications, dew point chart, and installation procedure. The non-cycling air dryer has a rated capacity of 10 scfm, and was especially designed for air conditioning applications. It protects pneumatic thermostatic controls against damaging moisture.

YOUR *New Catalogs* GUIDE

298 CORRUGATED ROOFING, SIDING

Philip Carey Mfg. Co.—Form 6482 illustrates corrugated asbestos-cement roofing and siding composed of Portland cement and asbestos fibres combined under pressure to form a homogeneous, monolithic sheet. The material is highly resistant to fire, acid and alkali fumes, salt air, rot proof and rodent proof. It never needs painting, but can be painted. Because deep corrugations provide beautiful shadow effects, it is often used for decorative purposes.

299 SERVICE PUMPS

Layne & Bowler, Inc.—Bulletin 300 shows applications of the short-coupled vertical turbine pump with cut-away of the bowl section.

300 HOT PROCESS SOFTENERS

Cochrane Corp.—Bulletin 4800 illustrates and describes hot process softeners for boiler plant water conditioning. Data is given on water treatment and the principles of operation of the firm's equipment are diagrammed.

301 RING LOCKED FASTENERS

Rosan, Inc.—Literature describes studs, inserts, bolts and nuts which are locked against rotation and joint looseness resulting therefrom by the firm's serrated locking ring. Ring locked fasteners are available for nonferrous as well as certain ferrous materials.

302 DESUPERHEATER

Copes-Vulcan Div., Blaw-Knox Co.—Bulletin 1037 illustrates and describes a variable-orifice desuperheater that holds reduced steam temperatures constant within 20 ft of outlet, even over load range as wide as 50 to 1. The unit needs no atomizing steam, no long downstream piping runs. Permanent pressure loss is 3 to 4 psig on all flows.

303 HEAVY DUTY COMPRESSORS

Pennsylvania Pump & Compressor Co.—Single stage, horizontal, water cooled, heavy duty air compressors in sizes from 10 to 150 hp and for pressures to 150 psig covered in Bulletin 350.

304 HUMIDITY AND TEMPERATURE CONTROL

Niagara Blower Co.—Bulletin No. 140, Hygrol Air Conditioning, describes means of manipulation of humidity and temperature, for critical processes of drying, holding heat-sensitive materials, and using absorbent liquid to dry air at moderate temperature without refrigeration. Diagrams, photos, chart of dehumidification capacities up to 20,500 cfm are included.

305 CUSTOM GEARS

Cincinnati Gear Co.—Illustrated folder describes and shows examples of types of gears produced to individual specifications only for all types of machinery and products. Gear types listed include spur; helical, rack, worm, herringbone, bevel, spiral bevel, internal, sprocket, Zerol (R) bevel and Coniflex (R) bevel; also custom gear boxes.

306 VALVELESS FILTER

Permutit Co. Div., Pfaudler Permutit, Inc.—Bulletin No. 4351 describes the company's automatic gravity sand filter for municipal or industrial water treatment. The unit uses no valves, pumps, or flow controllers, and is said to cost less than conventional manual filters, reduce costs of installation, operation, maintenance and expansion, and produce uniform high-quality effluent. Sizes up to 400 gpm are available.

307 PACKINGS

Linear Inc.—Eight-page folder contains tables of standard Vee-Dam fabric reinforced V-ring sizes as well as dimensional data for installation. Notes contain general recommendations for design, installation and gland adjustment. A description of 14 standard material recommendations for a wide variety of fluids, pressures, and temperature ranges is also included.

308 HEAT TREATING UNIT

Ipsen Industries, Inc.—Pusher heat treating unit is described in Bulletin P-59. Unit consists of a purge chamber, multi-zone furnace, forced cooling chamber, and an insulated quench tank. Features are discussed.

YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

309 VALVES

Walworth Co.—An eight-page, two-color brochure features cutaway views of bronze, cast iron, lubricated plug, and steel valves. In addition to explaining operation and showing outstanding characteristics of each valve, brochure pictures typical installations. For corrosive line fluid problems, polyvinyl chloride plastic valves and fittings are pictured and described.

310 DRAFTING MATERIALS

Frederick Post Co.—Ten separate catalog sections are each devoted to a particular phase of the engineering and drafting field. Over 6000 illustrated items, outlined in charts, provide a ready-reference to the line of sensitized products, reproduction machines, tracing and drawing media, drawing instruments, slide rules, drafting scales, drafting equipment, furniture, field equipment, and sundry supplies.

311 DEW POINT TRANSDUCER

Alnor Instrument Co., Div. of Illinois Testing Laboratories—Sales Engineering Bulletin 1502 covers the Alnor dew point transducer, which measures dew point in the range of −20 to 60 F. Continuous monitoring of the dew point is achieved by establishing a continuous flow of gas through the transducer. Indicating, recording controlling, and alarm readouts are available.

312 BALL BEARING MEASUREMENT

Micrometrical Mfg. Co.—The Anderometer is described in Form LT11. The instrument gives a numerical rating of the combined waviness of the balls and raceways of assembled ball bearings, expressed in units called anderons. Principal operating units are illustrated and discussed.

313 AIR CONVEYING SYSTEMS

Flo-Tronics, Inc.—Brochure describes air conveying systems for the bulk handling of powdered or granular materials. Publication also describes the numerous variations possible in the engineering of air conveying systems, including completely automated and programmed process controls. It is illustrated with diagrams showing typical equipment and systems arrangements.

314 ELECTRICAL PRECIPITATION

Aerotec Industries, Inc.—Illustrated eight-page Bulletin AI-101 outlines the development and basic steps of electrical precipitation of dust and then deals in detail with charging, precipitating, and discharging the dust particles. It includes a discussion of the back-ionization problem. Two types of suggested energy sources, silicon and electronic, are also described and illustrated, as well as a spark rate unit for control of the rectifier output.

315 ARC WELDING EQUIPMENT

Lincoln Electric Co.—A catalog of Lincoln manual arc welding equipment includes a complete description of electrodes for mild alloy and stainless steel welding and for hardsurfacing and nonferrous metal welding. It describes also motor generator, engine driven, transformer and rectifier welding machines and accessories.

316 DUCTILE IRON PUMPS

Food Machinery & Chemicals Corp., Peerless Pump Div.—Bulletin B 1314 describes series of single and multi-stage ductile iron pumps claiming excellent resistance to thermal shock and corrosion. Single stage Type A pumps available in sizes of 4 in. and larger has capacities to 60,000 gpm, heads to 400 ft. Type TU and TUT is multi-stage type, with heads up to 1500 ft, capacities of 3000 gpm.

317 FLAME DETECTOR

Bailey Meter Co.—Flame detector senses presence of a flame and operates an internal relay for alarms, tripping circuits, etc., or transmits a signal for use with an information system. It is described in Product Specification E66-2. The device monitors fuel burning equipment using coal, gas, oil and fuels in combination, and responds only to flame under surveillance.

318 SELF-LUBRICATING BEARINGS

Lubrite Div., Merriman Bros., Inc.—Manual No. 56 is a 24-page book with technical data and specifications about Lubrite self-lubricating bushings, bearings, washers, and expansion plates for use in machinery, industrial equipment, hydro-electric projects, missile and atomic energy applications, and high temperature applications.

319 DIFFERENTIAL SPEED REDUCERS

Winsmith, Inc.—A 16-page, two-color Catalog HM60 provides information on HM series horizontal motorized differential speed reducers. Literature contains engineering data, mounting information, service factors, horsepower, torque and overhung load ratings for the seven models in the new series, offering a ratio range of 1.1:1 to 50,000:1.

320 MAGNETIC DRIVES

Louis Allis Co.—Bulletin 3650 illustrates and describes liquid-cooled magnetic drives in ratings from 50 hp through 2500 hp for use on a broad field of adjustable speed applications. The drives feature simplified design with few moving parts and provide adjustable speed performance over an automatically regulated 20:1 range.

321 GENERAL PURPOSE COMPUTER

Bendix Computer Div., The Bendix Corp.—A brochure describes and illustrates the readily expandable, transistorized Bendix G-20 general purpose digital computer, for use in engineering, scientific, statistical, and data processing applications. Description covers central processor, accessories, programming, and specifications.

322 TEFLON PRODUCTS

Sparta Mfg. Co.—Six-page brochure reports on the capabilities of custom molded Teflon. Mechanical properties of TFE resins are given. Pictures show typical forms, shapes, and products. Research, planning, engineering, and production are discussed.

323 MIXING EQUIPMENT

Posey Iron Works, Inc.—Bulletin No. 25 covers Lancaster sifting and blending system, developed primarily for use in the preparation of ceramic bodies from pre-sized air-floated materials. Bulletins 710 and 715 describe Lancaster counter-current rapid batch mixers, rotating pan types for precision mixing and mulling. Tri-Rib blenders are the subject of Bulletin No. 60.

324 LIQUID LEVEL CONTROL

Magnetrol Inc.—Catalog Section 4A, 12 pages, describes universal liquid level control which uses "displacers" instead of conventional floats. Control units are operated through a magnetic coupling. Different types are illustrated and basic principles explained. Tables of specific gravities for different models are given.

325 VERTICAL TURBINE PUMP

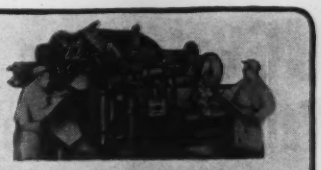
Johnston Pump Co.—A six-page technical bulletin gives information and illustrates the uses of the vertical turbine pump for handling volatile liquids or liquids near the boiling points. Adaptability of the pump to systems with zero or low net positive suction head characteristics is presented.

326 SYNTHETIC RUBBER

B. F. Goodrich Chemical Co.—Brochure "Hycar Rubber and Latex," 12 pages, describes B. F. Goodrich Hycar rubbers and their properties, using text and tables. General applications and uses are suggested for the different types and blends available.

327 INDUSTRIAL EQUIPMENT

Nordberg Mfg. Co.—A 24-page Bulletin 271 describes the complete Nordberg line of machinery; radial and inline two-cycle, and V and in-line four-cycle engines in diesel, gas, or Duafuel models; Power Chief diesel and gas engines and diesel engine generator sets; Symons primary gyratory crushers, cone crushers, vibrating screens and grizzlies; Gyradisc crushers, rotary kilns and dryers, and grinding mills; mine hoists; railway track maintenance machinery.



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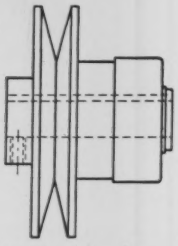

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Features include:

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- Infinitely variable over full speed range
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Sizes range from fractional to 1 hp., ratios to 2.8 to 1.

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328 INDUSTRIAL DOORS

Kinnear Mfg. Co.—Bulletin No. 104, a 36-page catalog, illustrates and describes the firm's line of doors and accessories for industrial use. Specifications on types and sizes of various doors are included, along with application information.

329 LIQUID LEVEL, FLOW CONTROL

McDonnell & Miller, Inc.—A 24-page booklet provides engineering information, schematic drawings on how to provide operating and safety controls for a variety of jobs involving liquid level and liquid flow.

330 PILLOW BLOCKS AND BEARINGS

Graphite Metallizing Corp.—Catalog 4 illustrates and describes solid and split self-aligning pillow blocks and hanger bearing assemblies with Graphalloy oilless bushings. They are designed to operate to 750 F in air in driers, ovens, conveyers, kilns, refuse burners; to 1700 F in non-oxidizing atmospheres. Also they are claimed to operate satisfactorily at −450 F.

331 BELT CONVEYORS

Link-Belt Co.—A 40-page handbook, Book 2779, covers the use and selection of standardized Pre-Bilt sectional belt conveyors. These are pre-engineered and shop-assembled from matched components, and are adaptable to a large proportion of belt conveyor applications and operating conditions.

332 CHEMICAL PROCESS PUMPS

Dean Brothers Pumps, Inc.—Circular 217 illustrates, describes, and gives capacities and specifications of a new line of chemical process pumps, Type "pH." Fourteen sizes in both horizontal and vertical are furnished in 14 corrosion resistant alloys.

333 CYLINDERS

Ledeen Mfg. Co.—A 12-page bulletin illustrates and describes the company's line of cylinders for air, oil, water, gas or steam operation in medium, heavy and super-duty construction. Selection information, ratings and limitations, and rod and head attachments are included.

334 STANDARD MOTORS

Sterling Electric Motors, Inc.—A 12-page colored brochure describes the firm's line of standard electric motors. The bulletin illustrates applications and contains selection information. Exclusive design advantages are described.

335 STRUCTURAL PANEL

Philip Carey Mfg. Co.—A folder, Form No. 6293 describes a 2-in-1 insulated structural panel for interior use in duct construction, industrial ovens, coil housings, plenum chambers. It is formed of laminated plies of corrugated and flat asbestos paper sheets, bonded with a fire-resistant adhesive suitable for continuous temperature up to 1000 F.

336 ROTARY GAS METERS

Roots-Connersville Blower, Div. of Dresser Industries, Inc.—Bulletin M-258 lists 39 sizes of rotary type positive displacement gas meters, for measuring flows ranging from 1000 to 1,000,000 cfh at pressures up to 125 psi. Descriptive data, dimensional information and installation views are provided. Certified meter proof tests on Bureau of Standards approved equipment offered.

337 HUMIDIFICATION EQUIPMENT

Bahnson Co.—Catalog Section 104 details the firm's line of industrial humidification equipment. Information and pictures describe and show various types of steam and water humidification equipment. The different uses, capacity, function, and operation of each type is explained.

338 ELEVATED STEEL TANKS

Pittsburgh-Des Moines Steel Co.—Bulletin 101, 20 pages, describes selection of PDM tanks engineered and fabricated for various water storage applications. Special sections are devoted to double ellipsoidal, ToroSpherical, radial cone bottom, pedestal spheroid, pedestal sphere and WaterBall design. Photos, accompanying tables and diagrams are included.

YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

339 ALUMINUM BEARINGS

Aluminum Co. of America.—Data is provided in two sections: first gives engineering data for the design and application of solid aluminum bearings and bushings (38 pages); second gives test data recorded from accurate laboratory and field tests of aluminum bearings (53 pages).

340 HYDRAULIC FLUID

Shell Oil Corp.—A technical bulletin covers Irus fluid 902, a fire-resistant fluid of hydraulic applications. Information is given on safety and tests, operating advantages of the fluid, preparation and maintenance of hydraulic systems.

341 SELF-ALIGNING COUPLINGS

Koppers Co., Metal Products Div.—A 16-page brochure describes principles and features of Fast's self-aligning couplings. Illustrates and describes each available standard and special model. Also available are four-page folders on Model B, forged steel, cast steel, mill motor flex-rigid and breaking-pin Jordan couplings.

342 VINYL, ABS AND POLYURETHANE

B. F. Goodrich Chemical Co.—A 16-page booklet describes properties and illustrates applications of Geon vinyls, Abson ABS materials and Estane polyurethane materials for industrial and consumer uses in extrusions, film and sheeting, molded products, expanded vinyls, coatings, and rigid materials.

343 AIR VELOCITY MEASUREMENT

Alnor Instrument Co., Div. of Illinois Testing Laboratories—Bulletin 1041 presents information on the Alnor air velocity transducer system for the measurement of low velocity air flow. Components are listed and discussed. Ordering instructions are given.

344 ELECTRIC MOTOR REWINDING

National Electric Coil Co.—Leaflet describes organization facilities for repair and rewinding coils of electric motors for steel, electric power, railroad and mining industries.

345 GASKETS

Garlock Packing Co.—Bulletin AD-104 describes the firm's Guardian spiral wound metal gaskets. The bulletin details features and design factors of the metal gaskets as well as the types available for specific applications.

346 PRECISION MEASURING VALVES

Lincoln Engrg. Co.—Bulletin 682 gives data on precision measuring valve systems for dispensing predetermined, metered quantities of fluids and semi-fluid materials. Operating characteristics are covered and various stationary systems.

347 REFRACTORIES

Carborundum Co.—Bi-monthly bulletins about refractories, their properties, uses and recent developments, are available. Subjects covered include muffled constructions, brickwork construction, research and development, a new silicon carbide refractory, wear resistance refractories, hot strength, heat resistance of refractories, thermal-shock resistance, chemical resistance, and stability.

348 OIL AND GREASE SEALS

National Seal Div., Federal Mogul Bower Bearings, Inc.—Catalog 58-A gives engineering, selection, and application data on oil and grease seals. More than 3000 sizes are listed covering 45 different types of seals, including a new line of "Bud" seals. National Seal Div. Sales Offices are also listed.

349 STEAM TRAPS

Armstrong Machine Wks.—An enlarged 48-page manual and steam trap catalog includes open float and thermostatic traps, pipe strainers to 6 in. in steel and semi steel, useful steam pipe sizing tables. Fundamentals of good trapping, trap selection, installation, testing, trouble-shooting, and repair are discussed.

350 AIRCRAFT BALL BEARINGS

New Departure Div., General Motors Corp.—A 16-page booklet covers the application of ball bearings in aircraft engines and accessories. Charts show the effects of load and speed, high temperature and tables show dimensions of bearings in a variety of flight applications.

351 SOLIDS—CONTACT REACTORS

Cochrane Corp.—A 24-page bulletin on solids-contact reactors contains a cut-away photograph and several pages of plane and elevation drawings showing the variety of designs available. The bulletin discusses theory and problems of cold water clarification, advantages and applications of various designs. Auxiliary and supplemental apparatus is described.

352 MEASURING WAVINESS

Micrometrical Mfg. Co.—The Wavometer is described in Form LT10. It measures the waviness around internal and external surfaces of rotation on a production basis. Causes and nature of waviness are explained, as well as how to control waviness. Information is given on principal operating units and components.

353 GAS SCRUBBERS

Aerotec Industries, Inc.—The centrifugal method of dry scrubbing for natural gas is the topic of illustrated Bulletin AI-102. Complete with dimensions, capacity charts and formulas, it permits the engineer to determine required sizes. Units up to 1,000,000 scfd may be manifolded to any capacity. Featured in bulletin is the Mist Extractor for use where excessive slugs of liquid are present in gas.

354 GEAR REDUCERS, INCREASERS

Lufkin Foundry & Machine Co.—Catalog G-4 covers engineering and dimensional data on standard lines of slow and medium speed herringbone gear reducers of single and double reduction type and high speed herringbone gear units for speed reducing or speed increasing service. Engineering data on selection of size is given.

355 FLOATING PRESS NUT

Rosan, Inc.—Literature describes simple one-press operation installation in thick or thin materials. Float of .030 is provided for joint hole alignment. Available in sizes No. 4, 6, 8, 10, and 1/4 in. Internal thread lock is optional.

356 FERROUS FORGINGS

American Brake Shoe Co., AmForge Div.—Illustrated 28-page booklet describes forging facilities and products. These include drop, upset, and press forgings. Case histories of savings through use of AmForge facilities are detailed.

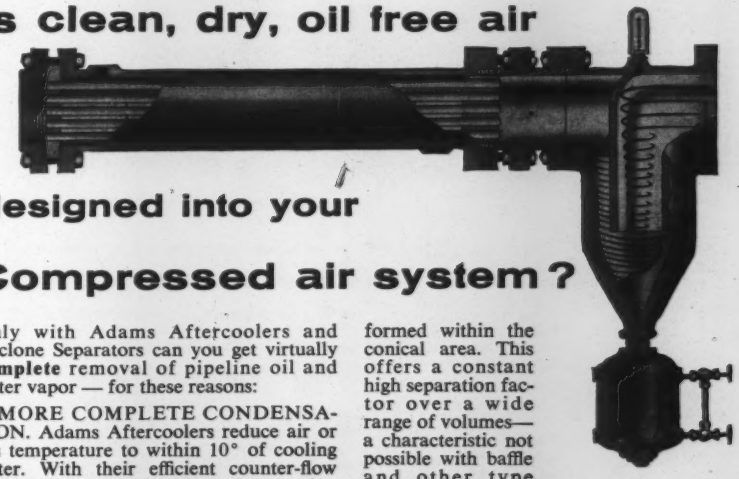
357 MATERIAL LEVEL CONTROL

Flo-Tronics, Inc.—Catalog sheet presents information on Model L400 and L400A Flo-Level, an electronic unit for determining the presence or absence of material at a selected level in a bin, hopper, storage tank, or similar container. The device is designed to fail safe in event of failure of any part of the unit.

358 PNEUMATIC CONVEYORS

National Conveyors Co.—Four-page Bulletin P58G describes pneumatic conveyor systems for handling bulk materials such as polyethylene and other types of plastic pellets, lime, alum, glass cullet, fine metal chips and borings, small parts.

Is clean, dry, oil free air



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New Bulletin 714 merits your attention for fullest possible protection to your air-actuated equipment. Write for your copy today.

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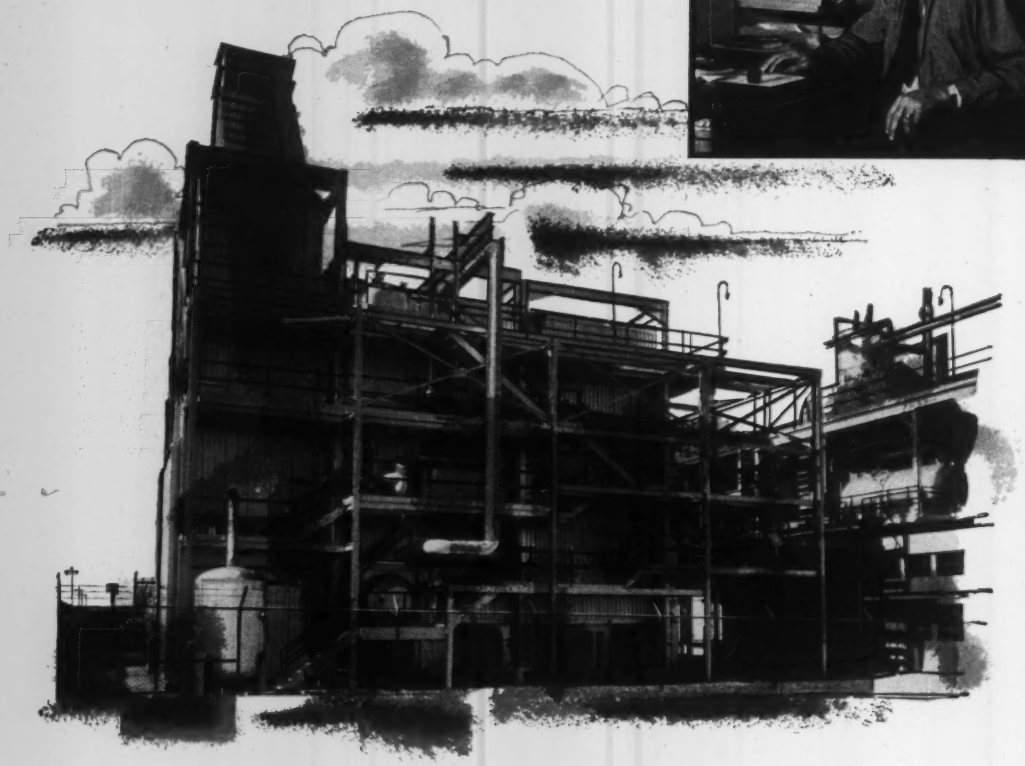
NEW WICKES STEAM GENERATOR

insures maximum efficiency and dependability for BRYAN, TEXAS, MUNICIPAL POWER PLANT

Calvin W. Beard, Superintendent of the Electric Utilities of Bryan, Texas, Municipal System: "As in every other power plant, our steam generator must give completely dependable performance day in and day out".



This Wickes Type RB 2 drum boiler is designed to produce 220,000 lbs. of steam per hour at 875 psig and 900° total steam temperature for the city of Bryan, Texas. The unit performs not only with remarkable dependability, but with Wickes' usual efficiency and economy. Wickes Boiler Co. builds steam generators in sizes to 500,000 lbs. of steam per hour, for high or low steam pressures and temperatures and for all types of fuels and firing methods. See your nearest Wickes representative for full information on a Wickes steam generator designed to suit your needs.

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Bulletin 55-1 gives details of a wide variety of designs and sizes of Wickes field-erected and shop-assembled steam generators. Write for your free copy.

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WICKES BOILER CO., SAGINAW 13, MICHIGAN, DIVISION OF THE WICKES CORPORATION

YOUR

New Catalogs

LATEST INDUSTRIAL LITERATURE

GUIDE

359 SPECIALTY STEELS

Crucible Steel Co. of America—Catalog lists descriptions of literature, technical aids and data sheets published by the firm in the field of utilization of specialty steel products.

360 DRAFTING ROOM EQUIPMENT

Hamilton Mfg Co.—Catalog No. 15 lists steel and wood drawing tables and files for every drafting room need. It includes comprehensive data on the Auto-Shift drafting table, information about the "L" table and shallow-drawer unit with tracing lifter, new Hamilton-Pack interlock files.

361 PIPE HANGERS

National Valve & Mfg. Co.—Bulletin 157 gives specifications for Counterpoise hangers, designed to provide a constant load supporting capacity for piping systems subject to vertical movement caused by expansion and contraction of piping with temperature changes. Levelglide hangers, which permit horizontal movement of piping systems, also are described.

362 CONDENSATE SCAVENGING

Graver Water Conditioning Co.—Bulletin WC-128 discusses the use of condensate scavenging-internal condensate purification- in high pressure central stations. The process, which employs filters or mixed-bed demineralizers or both, removes dissolved and suspended impurities from feedwater. The bulletin examines equipment and analytical procedures, and studies typical condensate scavenging installations.

363 PNEUMATIC INSTRUMENTS

Republic Flow Meters Co.—Six specification folios cover null-balance-vector pneumatic instruments for utility and process control systems. Described are controller, pressure transmitter, differential pressure transmitter, temperature transmitter, and ratio relays.

364 DRY DIAZO PROCESS

Charles Bruning Co., Paragon Revolute Div.—A six-page illustrated brochure explaining the basic features and applications of the Revolute Star whiteprinter. Cut-away illustrations of the machine are included along with specifications and explanations of the separation and development processes.

365 HIGH-STRENGTH STEEL

United States Steel Corp.—Form ADUCO-02741, 24 pages, describes properties and characteristics of low-alloy high-strength steel. Applications are illustrated.

366 BULK HANDLING CONTROLS

Electronics Control Div., Flo-Tronics, Inc.—Leaflet describes Flo-Tronics control instruments and equipment for bulk handling of dry materials. The many control points in a typical processing set-up are illustrated and some of the typical control instruments are tabulated.

367 PRESS NUT

Rosan, Inc.—Literature describes simple one-press operation installation in thick or thin materials. Firm states maximum push out and torque out are effected by exclusive locking system. Internal locking thread is optional. Units are available in sizes No. 2 through $^{3}/_{8}$ in.

368 BRAZING ALUMINUM

Aluminum Co. of America—Revised version of book presents practical shop data on brazing methods plus up-to-date information.

369 ULTRASONIC MACHINING

Sheffield Corp.—How to use ultrasonic energy to cut, drill, emboss, engrave, slice, and dice hard and brittle metals and nonmetals is shown in Publication No. CAV 7-56. The 16-page illustrated booklet describes the ultrasonic machining process, shows examples of designs and forms machined in carbide, glass, germanium, ferrite and ceramic, and also includes specifications and machining capacities of ultrasonic machine tools.

370 METAL HOSE

Flexonics Corp.—A 36-page design catalog covers application and selection of metal hose. Various end fittings are illustrated and described.

371 TORQUE CONVERTERS

National Supply Co.—Bulletin No. 496 describes single-stage torque converters for heavy industrial service, discussing background, design, types, sizes, circuits and applications. It also contains a capacity chart of the six sizes and 17 input ratings. Data sheets give application and dimension data of each of the six sizes, with performance curves, capacity chart, important features and typical torque converter arrangements.

372 PORTABLE GAS ANALYZERS

Ellison Draft Gage Co.—Bulletin 120 describes handy orsat type gas analyzer set for carbon-dioxide, oxygen and carbonmonoxide in stainless steel carrying case with instruction manual and portable gage included.

373 VIBRATING FEEDERS

Syntron Co.—A 32-page catalog covers standard and special model electromagnetic vibrating feeders for hard-to-handle bulk materials. Descriptions, data, and specifications along with installation photos and application diagrams.

374 INDUSTRIAL COOLING TOWERS

Marley Co.—Catalog contains information on design features, specifications and engineering data of new Series 15 Double Flow Aquatower. The Series 15 towers embody the functional and structural features of the rugged Marley industrial Double-Flow towers and the popular Double Flow Aquatowers.

375 BALL BEARINGS

New Departure Div., General Motors Corp.—Dimensions, load ratings, and mounting fits are detailed in the 24th edition of the company's ball bearing catalog. The 158-page book contains tables, drawings, and extensive selection data and specifications.

376 VALVES

Wm. Powell Co.—A 24-page booklet describes bronze, iron, steel, special metal, and alloy valves for handling water, oil, gas, air, steam, and corrosive fluids. It lists materials and gives the type, pressure, temperature ratings, sizes.

377 BIN LEVEL CONTROLS

Bin-Dicator Co.—Catalog describes and illustrates bin level indicators including new Roto-Bin-Dicator unit. Dimensional drawings, mounting details, typical applications, wiring diagrams.

378 CENTRIFUGAL PUMPS

Nagle Pumps, Inc.—A four page folder, Selector, gives briefing on the company's line of pumps for abusive applications. Horizontal shaft and vertical shaft pumps are shown, the latter designed to reduce stuffing box and bearing troubles.

379 AIR-GRAVITY CONVEYOR

Kennedy Van Saun Mfg. & Eng. Corp.—Bulletin 58-K illustrates and describes Air-Float conveyor for air-gravity conveying of dry free-flowing materials. Of principal interest to the cement, lime, and chemicals industries, the unit uses an exclusive porous plate for the conveying surface.

380 LAMINATED PLASTICS

Formica Corp.—A condensed catalog of technical information describes services and product areas of the company's industrial products section. Included is information on Copperclad laminates, laminate sheet sizes, moldings, rods, tubes post-forming, and special NEMA and special grade charts and a comparator chart.

381 VIBRATION TEST MACHINES

All American Tool & Mfg. Co.—Catalog F describes five new models of vibration fatigue testing machines equipped with electronically controlled drive motors and automatic range selector for variable acceleration control. Units are said to provide infinite frequency control within the range of 5 to 100 cps.

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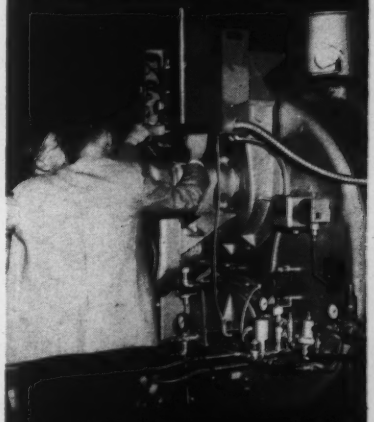
POWER GENERATION



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2522

24th NATIONAL EXPOSITION OF POWER & MECHANICAL ENGINEERING

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NEW YORK COLISEUM

NOV. 28—DEC. 2, 1960

MANAGEMENT: INTERNATIONAL EXPOSITION COMPANY
480 Lexington Ave., New York 17, N. Y.

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New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

382 FRICTION MATERIALS

Johns-Manville—A 16-page brochure, FM-35A, gives descriptions, design data, characteristics, and a reference chart of industrial friction materials including asbestos brake blocks, linings, and clutch facings.

383 UNIT HEATERS

Grinnell Co.—Bulletin UH858 illustrates and describes gas-fired, steam, and hot water unit heaters. Sound classifications are supplied for all models and capacities with recommendations for locations, unit selection, and installation. Advantages of double coil, single coil, velocity nozzles and vertical delivery units are explained for steam or hot water.

384 MOTION PICTURE CAMERAS

Wollensak Optical Co.—A catalog explaining high-speed photography, its application and the results obtainable and a folder describing the operation and uses of the Fastax high-speed motion picture-oscillographic camera are available. These cameras, used in research, design, commercial engineering, are a continuous moving film type with rotating prism positioned between the lens and the sprocket. They are available in 8, 16 and 35 mm in both 100 and 400 ft capacity.

385 AUTOMATIC MECHANICAL CLUTCHES

Mercury Clutch Div., Automatic Steel Products, Inc.—An eight-page folder gives specifications, applications and special data on the two general types of clutches for gasoline engines and electric motors. Also listed are representatives who are qualified to assist in the proper selection and application of the firm's clutches.

386 DUST FILTERS

W. W. Sly Mfg. Co.—A 36-page Bulletin 104 describes dust filters and gives engineering information on dust control systems. Operating principles of the firm's Dynaclone are described, and dust filter system specifications and hopper and support data are included.

387 FLEXIBLE COUPLINGS

Poole Foundry & Machine Co.—A 136-page manual illustrates, describes and gives engineering specification and lubrication data on flexible couplings.

388 TOOL STEELS

Crucible Steel Co. of America—Forty-six pages of information concerning tool steels for forging operation, the die casting process and the hot extrusion process. A series of charts detail the tool steel and heat treatments recommended for numerous forging, die casting, and extrusion operations. Also included is a brief trouble shooting guide.

389 PRESSURE CODE CHART

Missouri Boiler & Tank Co.—A wall chart provides a quick reference guide to ASME Boiler and Pressure Vessel Code (Section VIII). The chart illustrates some of the types of pressure vessel construction provided for under Section VIII, and furnishes direct references to the Code rules that apply.

390 ADJUSTABLE STORAGE RACKS

Sturdi-Bilt Div., Union Asbestos & Rubber Co.—Sixteen-page catalog shows how storage racks systematize storage of pallets, dies, drums, skids. It illustrates the systems by which prefabricated components are assembled (or disassembled) without tools, welding, nuts, bolts, or special labor. Catalog includes technical data including sizes, specifications, loads, applications.

391 IN-LINE ENGINES

Nordberg Mfg. Co.—Bulletin 257A describes four cycle diesel, Duafuel and spark-ignition gas engines. Installations discussed include municipal and industrial power plants, pipe line pumping stations and marine propulsion and auxiliary service.

392 EXHAUST PYROMETER

Alnor Instrument Co., Div. of Illinois Testing Laboratories—Subject of Bulletin 1418 is Alnor's diesel exhaust pyrometer which indicates exhaust gas temperature on a dashboard-mounted instrument scale, showing dangerous or normal conditions on red or green zone markings. Fuel savings, smoother performance, and reduced engine overhauling are claimed.

393 PILLOW BLOCKS

New Departure Div., General Motors Corp.—Ten-page bulletin illustrates and describes ball bearing pillow blocks. Construction features, load ratings, dimensions, interchange data, and engineering data is included.

394 OIL AND GREASE

Shell Oil Co.—Technical bulletins cover Darina grease, a multi-purpose microgel grease, and Dromus Oil E, a lubricant for high-speed metal machining operations.

395 HEAT AND POWER REFRACTORIES

Norton Co.—Thirty-two page brochure compiled for the benefit of boiler operator, setters, and engineers—to aid them in solving refractory problems and to help them obtain greater efficiency from their boilers. Also included is a temperature conversion chart, "Crystolon" brick specification tables and a quick-figuring efficiency chart for boilers.

396 BELLOWS

Flexonics Corp.—Twenty-page design guide covers application and selection of metal bellows for valve stem seals, steam traps, shaft couplings, shaft seals, and temperature or pressure sensing devices.

397 SQUIRREL CAGE MOTORS

Sterling Electric Motors, Inc.—A 64-page catalog illustrates a-c squirrel cage motors, speed reducers, and variable speed drives. Featured additions are right angle gear motors, right angle variable speed drives, and an expanded range of variable speed drives from 4660 to 1.3 rpm in variations from 2:1 and 10:1.

398 NUCLEAR FORGINGS

U. S. Steel Corp.—Six-page folder describes and pictures such forgings as rings, disks, closure heads, and vessel flanges, available for use in nuclear reactor construction.

399 PURIFIERS, MIST EXTRACTORS

V. D. Anderson Co.—Bulletin 803 itemizes principal applications of purifiers which remove liquid, solid and dust entrainment from gases and vapors. Information on internal, receiver and line type separators, mist extractors and scrubbers is included. Exhaust heads and high pressure purifiers designed to withstand pressures to 15,000 psig are also covered.

400 BALL THRUST BEARINGS

Gwilliam Co.—General Catalog describes, illustrates and lists standard sizes of various types of ball thrust bearings, roller thrust bearings, and journal roller bearings.

401 STORAGE WATER HEATER

Patterson-Kelley Co., Inc.—Twenty-page catalog describes design, operation, construction features and installation specifications of a new completely packaged Scalefree gas fired storage water heater.

402 AVIATION PRODUCTS

Aluminum Co. of America—A 16-page report covers recent accomplishments in research and development of improved products, construction of new facilities and increased production efficiency to solve aircraft industry problems of production economy and weight control in aluminum components.

403 THREAD INSERTS

Heli-Coil Corp.—Catalog on standard line of screw thread inserts designed for protection and repair of tapped threads in all materials is contained in Bulletin 652-A. Covered are design information, drilling and tapping recommendations, and specifications for various classes of fit. Also available is Bulletin 738 which provides similar details on new screw-lock insert which eliminates the need for lock washers, lock nuts.

404 GAGE LABORATORY INSTRUMENTS

Sheffield Corp.—A 20-page booklet illustrates and describes Accutron electronic dimensional inspection instruments. Applications, specifications on electronic height gages, internal and external measuring instruments, comparators are included.

405 GRINDING WHEELS

Norton Co.—A 30-page catalog with net price supplement covers Alundum and Crystolon grinding wheels for all types of operations. Also information and prices on abrasives for polishing and Tumblex abrasives for barrel finishing.

406 TURBINE SEAL

Koppers Company, Inc., Metal Products Div.—A 4-page folder on Huhn carbon rings for steam turbine applications discusses labyrinth, carbon garter spring ring and carbon ring sealing devices.

407 COPPER ALLOYS

Anaconda American Brass Co.—An enlarged edition of its "Copper & Copper Alloy Specifications Index" lists the most generally used alloys and products of the company, together with the applicable specifications of the eight following agencies ASTM, ASME, AWS, SAE, AMS, Federal Military, and Joint Army-Navy.

408 ELECTRONIC CHASSIS LATCH

Hartwell Corp.—A four-page, two-color bulletin gives information on the Gripwell electronic chassis latch. These latches are designed specifically for modular cabinets. The bulletin covers the Hartwell 307 latch, a large 5¼ in. chassis handle, and the Hartwell 316 latch, a smaller 4¾ in. handle. This bulletin is accompanied by sales outline drawings, and includes procurement information.

409 CENTRIFUGAL PUMPS

Pacific Pumps, Inc.—Bulletin FBA reproduces three illustrated articles devoted to the choice, design characteristics, and maintenance of centrifugal pumps. Twenty pages including physical laws controlling design and performance; characteristics of different types of centrifugal pumps; and materials of construction.

410 HYDRAULIC MULTIPRESS

Denison Engrg. Div., American Brake Shoe Co.—Catalog 120 illustrates and describes the firm's hydraulic multipress in 10 sizes from 1 to 75 tons capacity. General specifications and diagrams are included for the various models and accessories.

411 BEARING, JOINT SEALANTS

American Sealants Co.—Easier tolerances and improved alignment made possible with new techniques for retaining anti-friction bearings with Loctite sealant are described in a brochure. Also included is information on how to stop breakdowns due to loose nuts and bolts by using the liquid lockwasher and how to seal joints against high fluid pressures without mixing or pot life problems.

412 VARIABLE-SPEED DRIVE

Sterling Electric Motors, Inc.—Fractional horsepower Speed-Trol variable speed drive is described in an 18-page catalog. Prices, dimensions, and features of this lightweight, compact drive are included.

Free literature listed here may help you solve a perplexing power problem. Select catalog data carefully by number, then fill in coupon on page 152 and mail promptly.

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New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

413 HOSE, FITTINGS

Flexonics Corp.—Catalog No. 223 describes metal hose and fittings, with data tables, information on computing hose length, installation instructions, hose construction, etc. Interlocked and corrugated metal hose with re-usable and permanent fittings.

414 CYLINDER ACTUATORS

Conoflow Corp.—Data sheet describes the line of Series 50 Cylinder Conomotor actuators. The pneumatic actuator is used for precise proportional positioning of many types of processing equipment. Data Sheet 102 describes the operation and versatility of the Series 50 actuator. Complete specifications are listed and application examples illustrated.

415 SWIVEL AND ROTARY JOINTS

Sealol, Inc.—A six-page brochure describing swivel and rotary joints used in industrial applications. Typical applications, specifications, envelope dimensions, and torque curves are included.

416 OPTICAL LEVELING KIT

Keuffel & Esser Co.—Booklet entitled "A New Approach to Leveling" contains data on industrial alignment problems and solutions, including foundation or bed leveling, profiling, differential leveling, and checking movement of equipment. It also provides data on K&E's new Optical Leveling Kit, component parts, and available accessories such as tripods and related instrument parts.

417 POWER ROOF VENTILATORS

Ilg Electric Ventilating Co.—Eight-page condensed Catalog S 318 describes and illustrates line of heavy duty propeller and centrifugal type power roof ventilators for all commercial and industrial applications. Detailed selection data is given for each model including range of sizes and capacities.

418 BELT DRIVES

Browning Mfg. Co.—A 55-page catalog covers Gearbelt Drives that claim the flexibility of belt drives with the advantages of chain and gear drives. Power is transmitted by positive engagement of belt teeth with pulley grooves, as in chain drives, rather than by friction as in belt drives. The catalog contains specifications on stock items, design and installation suggestions, engineering data, examples, and tables of practical stock drive combinations.

419 PROCESS EQUIPMENT

Hardinge Co.—The company has just published an eight-page brochure on its complete line of process equipment for mining, chemical, stone, ceramics, water, sewage and industrial waste applications. Equipment for the following process operations are included: agitating and mixing, balling or pelletizing, clarifying, wet and dry classifying, cooling, drying, filtering, feeding, flocculating, grinding or pulverizing, lime treating, sampling, ore scrubbing, heavy-media separating and thickening. Laboratory or pilot-plant size equipment, for pulverizing and drying, is also described.

420 PACKAGED BOILER

Johnston Brothers, Inc.—Bulletin 200A describes the line of packaged boilers for heating or processing applications. Line is available to 250 hp, 15 to 150 lb working pressure and is equipped to burn preheated oil, cold oil, gas or gas-oil combination. Series feature water cooled combustion chambers and quiet air atomizing burners.

421 FILTERS

Cuno Engineering Corp.—A 48-page Catalog No. 51-100, describes the line of Auto-Klean and Super Auto-Klean filters. These are all-metal, edge type units which do not require cartridge replacement. A cut-away view is provided to demonstrate their self-cleaning action, and also a filter selector chart and a set of flow tables.

422 ALLOY STEEL

LaSalle Steel Co.—Two-page technical Bulletin No. 22 gives detailed information on LaSalle "e.t.d." 150 Alloy Steel Bars. Made by the patented Elevated Temperature Drawing Process, "e.t.d." 150 has a guaranteed 150,000 psi tensile strength, requires no heat treating, and is said to machine better than heat treated in-the-bar alloy steels.

423 UNIVERSAL JOINTS

Twin Disc Clutch Co.—A six-page catalog covers universal joints and propeller shafts. Torque capacity and dimensional data are given for large and extra-large size roller bearing joints running from 5000 to 564,000 lb-ft torque.

424 TORQUE MOTORS

Inland Motor Corp.—Line of precision electrical and electronic components is described in a catalog entitled, "Torque Motors and Control Amplifiers." It includes a brief narrative defining terminology, pointing up advantages of d-c torquers and presenting mechanical and electrical characteristics of standarized torque motors and associated power amplifiers.

425 FLASH BUTT-WELDING RINGS

American Welding & Mfg. Co.—A 20-page illustrated booklet describes how the firm produces rings and circular products. Photographs, drawings, and charts illustrate the methods used to form bar stock by bending and how it is welded to produce rings used in aircraft, missile, and other industrial applications. Specifications peculiar to flash butt-welded rings, quality control procedures, and testing are discussed.

426 INDUSTRIAL POWER TOOLS

Rockwell Mfg. Co., Delta Power Tool Div.—Drill presses, grinders, shapers, planers, jointers, metal and wood cutting lathes, tilting arbor saws, unisaws, band saws, and radial saws are described in an 88-page catalog. Specifications, catalog listings, and descriptions of accessories for all tools are included.

427 VALVES

Ledeen Mfg. Co.—A 16-page bulletin illustrates and describes the company's line of hand, foot, power and solenoid operated valves, air, oil, gas and water powered. Bulletin gives operating and flow cycles, dimensions and weights.

428 SUPERIOR BEARING METAL

Bearium Metals Corp.—Brochure, illustrated with photographs of a Torture Test, and describing nonseizing, nonscoring aspects of Bearium Metal. Metal available in rough-cast bars, pattern castings, centerless-ground rods, and machined parts.

429 CHEMICAL TREATMENT

Layne & Bowler, Inc.—Six-page folder illustrates and describes chemical treatment for water wells. It lists treatment materials and shows microphotos of bacteria found in wells.

430 TRANSMISSION BELT

Manhattan Rubber Div., Raybestos-Manhattan, Inc.—Literature covers the new Poly-V "J" belt, especially designed for high-speed, small-pulley power transmission applications. It will operate over sheaves as small as 0.8 in. pd. Pitch lengths range from 8 to 98 in.

431 STEEL SMOKE STACKS

Koven Fabricators, Inc.—Bulletin gives size, capacity, and engineering information on steel smoke stacks. A formula for figuring anchor bolts for self-supporting stacks and a formula for figuring guy wire for guyed stacks are included. A table also covers the effects of force of wind on stacks.

432 MANUAL CHUCKS

Cushman Chuck Co.—Catalog No. 67-1959, with companion price list, contains listings and detailed engineering data on manually operated chucks for both older and new standard spindle noses.

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PIPING AND INSULATION

The upsurge in demand for piping: alloy, stainless, cement, brass, copper, wrought iron, carbon steel; and new ways to insulate it with asbestos, plastic, fiberglas, ceramic, and other materials, keep men of power on their toes to keep in step with new, cost-saving developments.

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Only at the Power Show do you have the opportunity to investigate, compare and get the right answers, face-to-face, from the manufacturers themselves. Only at the Power Show can you see over 250 leading suppliers' products, all conveniently grouped together at one time.

Make sure you're there. Everyone else will be!

2446

24th NATIONAL EXPOSITION OF POWER & MECHANICAL ENGINEERING

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NEW YORK COLISEUM

NOV. 28—DEC. 2, 1960

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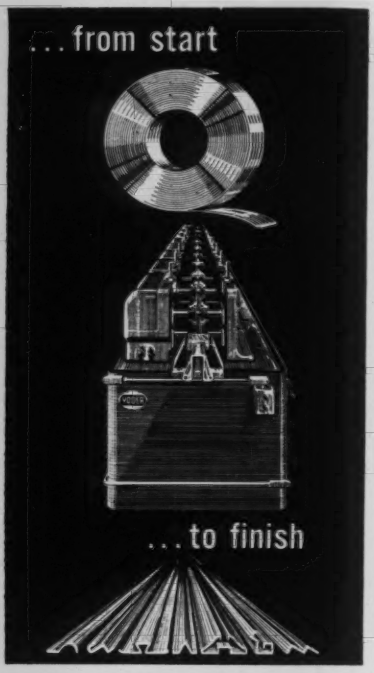

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LATEST INDUSTRIAL LITERATURE

433 ELECTRICAL CONTROL CABINETS

Industrial Equipment Co.—Brochure shows sizes and construction of metal cabinets for electrical and hydraulic control panels. Special types shown.

434 PLUNGER TYPE FASTENER

Hartwell Corp.—An eight-page bulletin describes the Nylatch push-pull plunger-type fastener designed for rapid fastening in metals, wood, and synthetics. This bulletin gives details on test information concerning grip, tension load, flexibility, and versatility of this type of fastener, complete with procurement information.

435 PIPELINE PUMPING

Dravo Corp.—Bulletin 1704 illustrates a part of the firm's record of engineering construction of pipeline pumping and compressor stations for the transmission and storage of gas and petroleum products.

436 VIBRATING FEEDERS

Link-Belt Co.—Straightline vibrating feeders are described in the six-page Folder 2770. Materials handled include: iron and nonferrous ores, coal, rock, slag, shale, clinker, gravel, and foundry sand. Two models can be either cable-suspended or floor-mounted, are available in 30 sizes with capacities up to 1350 tph.

437 EXPANSION COMPENSATORS

Flexonics Corp.—Bulletin 205 describes new high-pressure expansion compensators in stainless steel and bronze. Units have been especially designed to replace the previous methods of expansion compensation, such as slip joints, swing joints, pipe loops, or bends; units are available in pressures to 175 psig, temperatures from −60 to 250 F, and 1¾ in. compression and ¼ in. extension.

438 BOILER FEED PUMPS

Pacific Pumps, Inc.—Bulletin 122A illustrates and describes in 12 pages Pacific Type BF1 boiler feed pumps for high pressure service. It includes conversion curves, formula for calculating net inlet head as well as detailed construction data.

439 X-RAY GAGE

Sheffield Corp.—The Measuray, a non-contact X-ray gage for measuring the thickness of metals or nonmetals in strip or sheet while in motion or stationary, is described in Catalog No. AU-113-57. Materials checked include hot or cold strip steel, brass, copper, aluminum, plastics, foils, coated fabrics, films, rubber.

440 AUDITORIUM AIR CONDITIONERS

John J. Nesbitt, Inc.—Catalog 22 illustrates and describes AudiCon air conditioner, designed especially for school auditoriums and other large assembly areas where quietness is important. Unit features silencer discharge plenum, plus return air bypass control.

441 SPRING PINS

C. E. M. Co.—Catalog lists prices, dimensions, technical information on heavy, medium, and light duty Spirol spring pins in carbon steel, chrome stainless steel, and nickel stainless steel. Typical applications are illustrated.

442 LUBRICATION EQUIPMENT

Oil-Rite Corp.—Catalog No. 10 describes lubricating equipment from plain oil cups to completely automatic systems. Applications of this equipment in the supplementary reports show how it is used to reduce maintenance and lubricant costs and prolong the life of production machinery.

443 MATERIALS HANDLING

Syntron Co.—A condensed catalog, No. 605 contains 68 pages of technical data, brief description and photographs of bin vibrators, vibratory feeders, vibratory conveyors, power tools, shaft seals, selenium rectifiers, vibrating parts feeders, and other equipment.

444 VIBRATION, NOISE CONTROL

Korfund Co.—Eight-page booklet K4H gives engineering specifications and performance data for 27 types of products for the control and measurement of machinery vibration, shock, and noise. Installation photos show a variety of equipments and tell how typical problems were solved.

445 PUMPS AND AIR COMPRESSORS

Worthington Corp.—A 24-page brochure detailing information on Standard industrial pumps and air compressors. Also included is hydraulic data and descriptive material on Worthington steam, rotary, power, centrifugal, regenerative turbine and circulating pumps. Also compressed air data and material on Worthington air compressors.

446 STEREO-ZOOM-MICROSCOPES

Bausch & Lomb—A catalog discusses principles and equipment used in connection with stereomicroscopy. A guide to the selection of stereomicroscopes and accessories is included. Catalog D-15

447 CONTROLS, INSTRUMENTS

Fischer & Porter Co.—A 54-page catalog describes the company's products including indicating, recording, controlling, and transmitting instruments for flow, pressure, temperature, density, viscosity, and consistency.

448 DEAERATORS

Permutit Co., Div. of Pfaudler Permutit Inc.—Bulletin 4732 contains details on the construction operation, and other advantages of the Permutit tray deaerator.

449 FASTENERS

Hartwell Corp.—A 75-page catalog is devoted to trigger action latches, self-closing latches, and flush hinges. This catalog carries 75 different latches, with complete procurement information incorporated, along with sales outline drawings of these particular latches.

450 THERMOCOUPLE REFERENCE JUNCTION

Pace Engineering Co.—Data sheets describe a precision and a utility series of Thermocouple Reference Junctions of multi-channel temperature measurement systems. Included list of special circuit features, thermocouple combinations, specification on temperature stability.

451 PILLOW BLOCK BEARING

Triangle Mfg. Co.—Forty-page catalog covers applications, variations, lubrication, and installation of pillow block bearings and mountings. Included are sleeve-type, self-aligning pillow blocks, single-bolt mountings, wall bearings, pedestal bearings, tri-arm bracket assemblies, plain and cushioned flange mountings.

452 ELECTROMAGNETIC CLUTCHES

I-T-E Circuit Breaker Co.—Information on its complete line of electromagnetic clutches, in six series with torque capacities from 1.8 through 13,000 lb-ft is furnished in a 20-page bulletin. Design, specification and application material, including photographs, drawings, and sketches, are included.

453 CHEMICAL FEEDER

B-I-F Industries, Inc., Proportioneers Div.—Design features of Model 1210 Chem-O-Feeder are covered in Bulletin 1210.20-1. Low cost, dependable, positive displacement pump, designed for ease of installation, minimum maintenance, and elimination of air binding. Available with one, two, or three "See-thru" chemical reagent heads.

454 CENTRIFUGAL PUMPS

Pacific Pumps, Inc.—Bulletin 140 covers a line of multi-stage, opposed-impeller, centrifugal pumps to handle hot or cold water, hydrocarbons, chemicals, acids, condensates, and similar liquids. They can also be adapted for medium-pressure boiler feed service and, with minor modifications, they become efficient hydraulic driving devices.

YOUR

New Catalogs GUIDE

455 REFUSE INCINERATOR WALLS

Bernitz Furnace Appliance Co.—Bulletin B-58 describes silicon carbide air-cooled blocks for incinerator walls. The blocks are designed to improve combustion, insure long furnace wall life, and reduce maintenance and down time.

456 CORROSION RESISTING PLASTIC

Joseph T. Ryerson & Son, Inc.—Technical Bulletin 80-3 provides engineering data on Ryertex-Omicron PVC plastic. Included are tables of properties, advantages, chemical resistance to various media, fabricating instructions, pipe installation suggestions, bar, pipe, and sheet sizes, and illustrations of applications.

457 PRESSURE REGULATORS

OPW-Jordan Corp.—Eight-page Catalog J160-1 describes sliding gate pressure regulators, available in self-operated, pilot-operated, solenoid-operated, and back pressure models. Sizes are 1/4 to 6 in. Catalog gives illustrations, features, cutaways, dimensions, materials, and sizing charts.

458 TECHNICAL BOOKS

Lefax Publishers—A revised catalog covers pocket size technical data books. The books cover every field of engineering, including aeronautics, air-conditioning, automotive engineering, diesel engineering, home heating, machine design, machinists' data, mechanical drawing, mechanics of materials, metals, piping data, power transmission machinery, steam engineering, thermodynamics tables and charts, general mathematics, five-place trig. and log. tables.

459 DIP-PROOF MOTOR

Sterling Electric Motors, Inc.—Bulletin contains information on a new Sterlicone multi-shielded a-c drip-proof motor, available to replace totally enclosed fan cooled motors in many applications. Features are presented and possible savings are outlined.

460 QUICK-RELEASE PINS

Hartwell Corp.—A four-page, two-color brochure describes single- and double-acting quick-release pins. This literature is accompanied by 15 sheets of sales outline drawings, procurement information, and NAS numbers.

461 QUICK HOSE-CONNECTOR

Besler Corp.—Folder gives data on a quick hose-connector for pressures to 5000 psi. The unit, used on military aircraft, is designed for high pressure gas and liquid. Data is also provided on a new tank pressurizing control valve.

462 AUTOMATIC LIQUID LEVEL GAGES

Liquidometer Corp.—Bulletin 463A describes 100 per cent automatic remote reading tank gages. Information on direct reading gages at tank and hydrostatic type remote reading gages.

463 BOILER, TANK CONTROL

Commercial Shearing & Stamping Co.—Three catalogs are offered. Catalog P-2 covers products for boiler and tank manufacture; 200-CI, standard metal shapes available without tool and die charge; 900-P5, stampings, forgings, rotoforms.

464 DEEP DRAWN SHELLS

Pressed Steel Tank Co.—A bulletin summarizes basic applications and economies possible using seamless cupped and deep drawn ferrous and nonferrous shells. Included is information on head shapes and types of open ends available, practical diameter to length ratios, wall thicknesses.

465 STAINLESS AND HIGH ALLOY PIPE AND TUBING

Trent Tube Co., Subsidiary of Crucible Steel Co. of America—A 48-page manual detailing the complete operation of Trent Tube, manufacturers of Contour Trent Tube, manufacturers of Contour Trentweld, stainless steel and high alloy pipe and tubing. Included is information on Tubing Classifications—plus charts and tables applying to each class. Corrosion characteristics, weights, properties of alloys and conversion tables.

466 PORTABLE TESTER

Hunter Spring Co.—Bulletin 750e describes a new portable tester originally developed for testing the mechanical strength of solderless electrical terminals but suitable for other tensile testing. It is available in seven models for ranges from 0–20 up to 0–500 lb.

467 ASBESTOS-CEMENT BOARD

Phillip Carey Mfg. Co.—Form 6285 describes asbestos-cement board for exterior walls, partitions, linings, utility structures. The material is not affected by most acids, alkalis, fumes, heat, cold, weather, salt air. It is vermin and rodent proof, will not rot, rust or corrode, and needs no paint or protective coating. It can be painted for decorative purposes. Suitable for continuous temperatures up to 600 F.

468 ABSORPTION COLD GENERATOR

Trane Co.—Catalog covering the firm's absorption cold generator describes product features, absorption operational cycle, hermetic pump operation, purge design, and gives roughing-in dimensions and specifications.

469 SPREADER STOKERS

Hoffman Combustion Engineering Co.—Catalog No. 55-CAD describes and illustrates features of moving-grate spreader stokers. Catalog 55-PDG describes, illustrates, and supplies additional information on the spreader stokers with dumping grates. Capacities from 20,000 to 500,000 lb of steam per hour.

470 PNEUMATIC CONVEYING SYSTEM

Spencer Turbine Co.—Bulletin No. 143-B describes stationary and portable pneumatic conveying systems. Systems cover a capacity range from 1/4 through 10 tons per hour; vacuum producers from 5 through 75 hp, and hose or pipe sizes from 2 through 7 in. Coveying under both pressure and vacuum is covered, and applications are illustrated. Specific information is provided on size of unit, rate of conveying, and type and weight of material in each case.

471 EXPANSION JOINT DESIGN GUIDE

Flexonics Corp.—A 32-page expansion joint design guide, Catalog no. 222, covers engineering application and selection data. A discussion of the various types of expansion joints on the market, types of pipeline motion solved by expansion joints, expansion joint design considerations, installation instructions, and selection data is included.

472 SHAFT MOTION INDICATORS

Bin-Dicator Co.—Catalog describes and illustrates Roto-Guard shaft motion indicator, a compact, low-cost unit for attachment to machines in process and other industries to give positive indication of motion, slow-down or stoppage of machinery. Can actuate signals, controls. Dimensional drawings, mounting details are included.

473 BELT CONVEYORS

Transall, Inc.—Four page brochure outlining the advantages of Transall prelubricated belt conveyor idlers. A check point list is included.

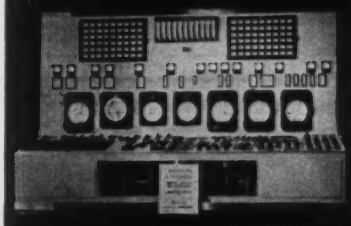
474 TRANSDUCERS

Consolidated Electrodynamics Corp.—A 16-page folder, No. 1308, on transducers and associated equipment, illustrates and describes vibration pickups, velocity pickups, torsiographs, pressure pickups, dynamic pressure pickups, galvanometers, and telemetry equipment.

Read carefully . . . select wisely, then send coupon on page 152 now for your free catalogs. Requests limited to 25 catalogs. (Sorry, no catalog distribution can be made to students.)

WHAT COMES UNDER

ENERGY CONTROL?



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NOV. 28—DEC. 2, 1960

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480 Lexington Ave., New York 17, N. Y.

475 GENERATORS, BOILERS

Wickes Boiler Co.—Bulletin 55-1 gives information on the facilities and products of the company including drawings of typical steam generators and shop-assembled water tube boilers. Units shown from 15,000 lb capacity of steam per hour to 300,000, designed to operate to 1000 psi. Duotherm vaporizers, economizers, superheaters, and airheaters are included.

476 REVERSING DRIVE

Funk Mfg. Co.—A catalog illustrates and describes the firm's Reverse-O-Matic drive said to be adaptable to any equipment that has forward or backward, or up and down motion, such as road rollers or fork lift trucks. One-lever controls speed and change of direction. Standard flanges adapt it to other power transmission components, including power take-offs, right-angle drives, transmission and gear reduction.

477 COLD ROLL FORMING

Yoder Co.—An 88-page reference manual on cold roll forming covers operating speeds, tooling, personnel training and operating techniques, surface finish, uniformity, forming of pre-coated stock, selecting proper equipment.

YOUR *New Catalogs* GUIDE

478 PRECISION COMPONENT

PIC Design Corp.—New 416-page Master Catalog lists with drawings and prices of 10,000 stock parts for breadboard, development, and production. The catalog includes gears, differentials, speed reducers, shafts, gearings, couplings, breadboard, kits, tool components.

479 AIR COMPRESSORS

Gardner-Denver Co.—Twelve-page bulletin illustrates and describes two-stage water-cooled air compressors for use throughout general industry.

480 FLIGHT CONVEYOR

Link-Belt Co.—Folder 2813 is a four-page publication of Flite-Flo, a new fully enclosed, self-cleaning flight conveyor. It gives dimensions, capacities, and other specifications on the units which can handle free flowing, granular nonabrasive bulk materials in horizontal or limited inclined paths.

481 TECHNICAL BOOKS

Ronald Press—Brochures contain detailed descriptions of current technical books on mechanics, hydraulics, electronics, aerodynamics, plasticity, air conditioning, electrical engineering, etc. Basic studies and pioneering works on late engineering developments are included.

482 INSTRUMENTS, SYSTEMS

Gulton Industries, Inc.—Four-page facilities brochure covers the firm's instruments and divisions in the field of electronics, electricity, ceramics, telemetry, and other devices for use as single components or complete systems.

483 CENTRIFUGAL PROCESS PUMPS

Pacific Pumps, Inc.—Bulletin 135 contains data, dimensions, and selection chart on Pacific's centerline mounted Type SVE pumps. Bulletin 136 contains similar data on Pacific Type SVA single stage, single inlet centrifugal pumps.

484 QUICK OPENING DOORS

Struthers Wells Corp.—Bulletin SW-553 covers quick opening doors for processing equipment. Automatic or semi-automatic in operation, the units are available in Ring-lok or Wedg-lok types, designed for vulcanizers, devulcanizers, impregnators, sterilizers, cement block curing vessels, ovens, and creosoting cylinders.

485 LATCHES AND HANDLES

Hartwell Corp.—A 50-page, two-color catalog contains information on hook, pin, and rotary latches, plus handles. This catalog contains sales outline drawings of these various fasteners, along with procurement information.

486 AIR SUPPLY LINE ACCESSORIES

Lincoln Engrg. Co.—A 16-page catalog describes a new line of air supply line accessories, including sockets, plugs, fittings, hose clamps, and tools.

487 METAL CONSTRUCTION

Pittsburgh-Des Moines Steel Co.—A 36-page general brochure describes the capabilities and diversities of engineering, research, fabrication and construction of steel, stainless steel, stainless clad steel, alloy, and aluminum.

488 GAGING CARTRIDGES

Sheffield Corp.—A 32-page booklet gives application data on the use of Plumjet air gaging cartridges with instruments. Included are types, sizes, amplification tolerance, and range of the units. Engineering and technical data for applying them to single and multiple dimension inspection and machine control is included.

489 PLANT CONSTRUCTION

Nooter Corp.—Catalog No. 258 describes, by example, the firm's field construction department for fabricating and erecting processing equipment for such industries as chemical, petroleum, brewing, food, pharmaceutical, and public utilities.

490 ELEVATED TANK

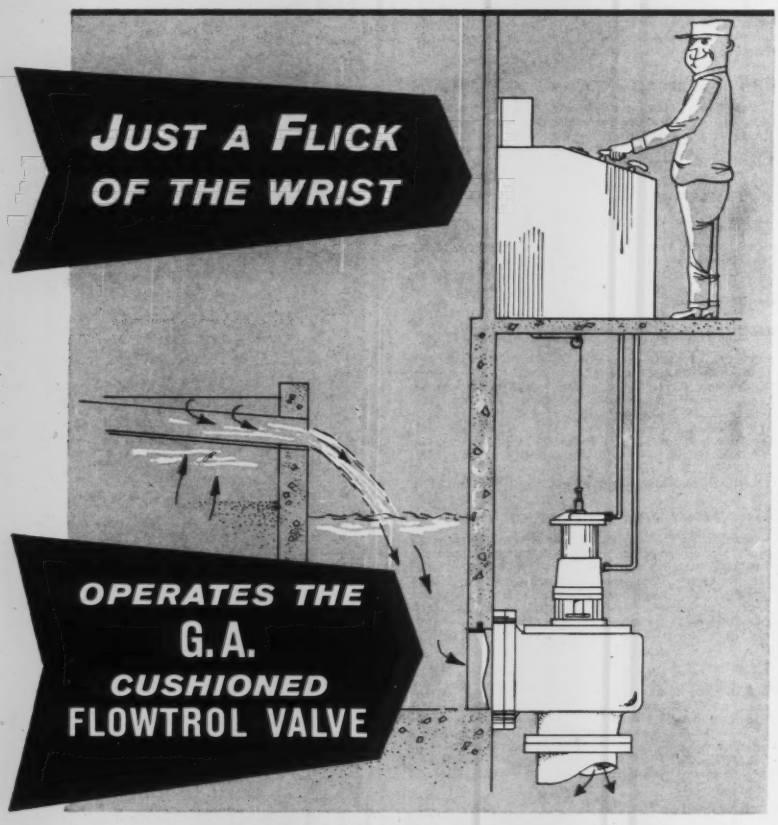
Graver Tank & Mfg. Co.—Colored folder sets forth the design features and advantages of a new form of elevated water tank called Aquatore. Tank designed as a torus tank on a flared column provides storage for 300,000 to 3,000,000 gal.

491 DOME PRESS NUT

Rosan, Inc.—Literature describes simple one-press operation installation in thick or thin materials. Firm states ideal fastener for potting. Internal thread lock is optional. The units are available in sizes No. 2 through $^{5}/_{16}$ in.

492 VACUUM PUMPS

Leiman Bros., Inc.—A 16-page catalog, No. 460 describes rotary positive air and vacuum pumps, gas boosters and air motors. Included are 2 and 4 wing types; fan-cooled, water-cooled and new radiator air-cooled models; motor driven units; direct-coupled and belt-driven models, integral pump and motor; automatically controlled tank units; accessories.



Regardless of the size of the valve or the pressure in the line, just a simple quarter turn of the 3-way pilot at the control station fully opens or tightly closes this G-A Valve. No manual effort, no handwheels, no motors, no levers are needed.

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LATEST INDUSTRIAL LITERATURE

493 RIGID PVC PIPE

B. F. Goodrich Industrial Products Co.—Bulletin 10050 covers properties, chemical resistance, design data, specifications, and installation of Koroseal rigid vinyl piping.

494 OIL FILTERS, STRAINERS, OILING SERVICES

Wm. W. Nugent & Co., Inc.—Seven bulletins. No. 6 illustrates and describes Nugent pressure strainers; No. 7 gravity filters; No. 7A pressure filters; No. 8 tanks, pumps, shaft oilers; No. 14 oiling and filtering systems for turbines, paper mills, steel mills, pumps, compressors; No. 15 oiling devices; No. 16 sight feed valves, multiple oilers, flow indicators, sight overflows, and compression union fittings.

495 THERMOCOUPLE SYSTEM CALIBRATOR

Pace Engineering Co.—A manual gives the theory and operation of equipment for calibrating multichannel thermocouple recording systems. The calibrator is one in which the reference temperature and scale are established by injection of monitored voltages supplied by two mercury cells.

496 HONING EQUIPMENT

Micromatic Hone Corp.—A 32-page catalog, AR-140, explains Microhoning process, including stock removal and automatic size control. Applications, specifications, work capacities of machines for small, medium range diameters, long stroke vertical machines, horizontal machines, multiple-spindle machines are given.

497 AIR COCKS

Westinghouse Air Brake Co., Industrial Products Div.—A four-page catalog illustrates and describes plug type and diaphragm type two and three-way cut-out cocks for pneumatic systems.

498 TECHNICAL BOOKS AND PAPERS

The American Society of Mechanical Engineers—A 24-page catalog describing current books, standards, codes, research reports and periodicals published by the Society, also a listing of available technical papers.

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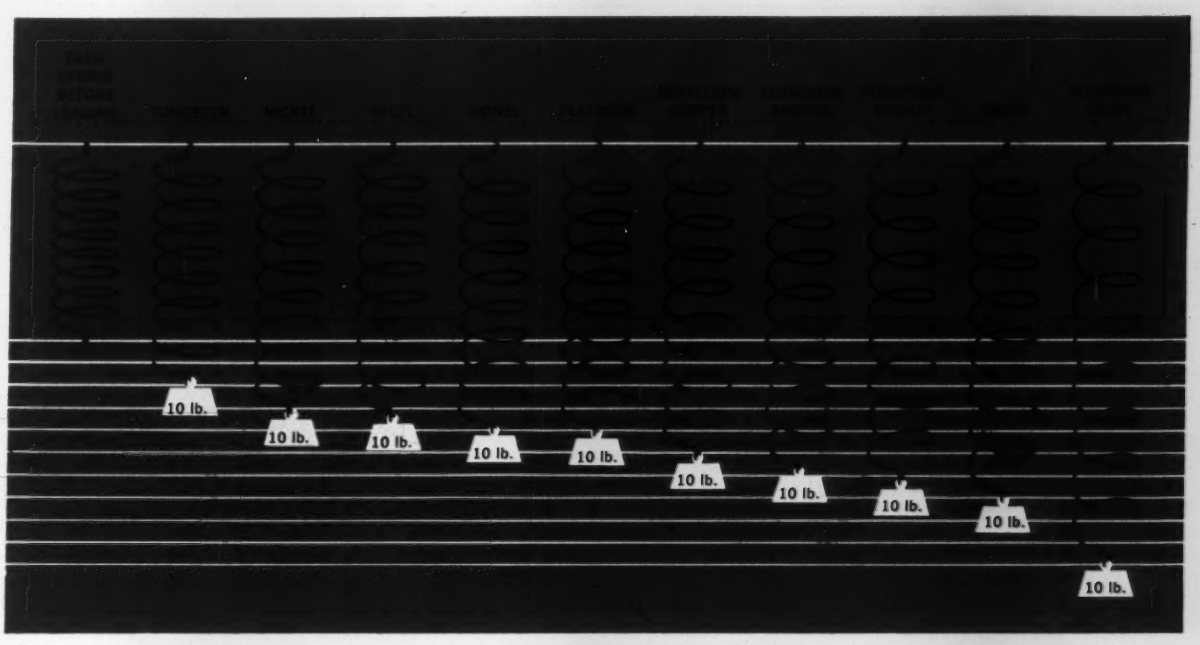

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B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Mattoon, Ill.
Milwaukee Division, Milwaukee, Wis.
Seaboard Pacific Division, Gardena, Calif.

Canadian Subsidiary: Wallace Barnes Co., Ltd., Hamilton, Ont. and Montreal, Que. Puerto Rican Subsidiary: Associated Spring of Puerto Rico, Inc., Carolina, P.R.

Here are the AMERICAN STANDARDS to consult —
for approved dimensions, permissible tolerances, and other specifications
covering SMALL TOOLS AND MACHINE TOOL ELEMENTS

ACCURACY OF ENGINE AND TOOL ROOM LATHES, B5.16—1952. $1.00
Gives the tolerances to which industry is building 12 in. to 18 in., 20 in. to 32 in., and 40 in. to 72 in. lathes and the tests for determining the accuracy of the lathes.

CHUCKS AND CHUCK JAWS, B5.8—1954. $1.50
Establishes controlling dimensions for all chucks from 6-in. to 36-in. diameter of both medium and heavy duty types, for an extra heavy series of chucks with serrated master jaws, for power-operated and hand-operated chucks of two-, three-, and four-jaw types.

CIRCULAR AND DOVETAILED FORMING TOOL BLANKS, B5.7—1954. $1.50
In this standard are the sizes and types of tool blanks and the associated mounting portions of their respective holders for use on 60 types of automatic screw machines, the latter being classified in the standard into six different groups of comparable stock capacities. Tolerances and screw threads are specified. Typical blanks and holders are illustrated.

CARBIDE BLANKS AND CUTTING TOOLS, B5.36—1957. $2.00
Gives the sizes, styles, designations. dimensions and tolerances of eight styles of sintered carbide blanks, tipped tools with square or rectangular shanks, boring tools and tool bits, and inserts 1½" long and their holders.

DESIGNATION AND WORKING RANGES OF GRINDING MACHINES, B5.32 and 33—1953. $1.00
Data and information supplied by this standard apply to all sizes of reciprocating table surface grinders having horizontal spindles and to all swings of plain cylindrical grinding machines up to and including 36 in. size.

DRILL DRIVERS (Split-Sleeve, Collet-Type), B5.27—1959. $1.50
This standard gives taper dimensions, general specifications, and the dimensions for 151 sizes of drill drivers along with the standard and optional taper number for each size.

DRIVING AND SPINDLE ENDS FOR PORTABLE AIR AND ELECTRIC TOOLS, B5.38—1958. $1.50
These dimensions and tolerances are for both driving and driven elements of portable powered tools of either air or electric type. Also covered are threaded spindles for geared chucks and abrasion tools, Jacobs tapers and hexagonal and square drives.

HIGH SPEED STEEL AND CAST NONFERROUS SINGLE POINT TOOLS AND TOOL HOLDERS, B5.29—1959. $1.00
The tools for which sizes and tolerances are given in this standard are those in common usage for general purpose machine. Additionally the standard gives the nominal shank sizes of tool bit holders.

NSERTED BLADE MILLING CUTTER BODIES B5.23—1958. $1.50
In this standard are the dimensions and dimensional tolerances of cutter bodies for shell end mills, half side mills, staggered-tooth side mills, face mills—flat back series, and face mills—series 50 in a diameter range of 3 to 24 in.

INVOLUTE SPLINES, SERRATIONS AND INSPECTION, B5.15—1960. $5.00
In this new standard data are presented in a form that pin-points application rather than tooling problems. Specifically it provides guidance and data for the design of straight (non-helical), involute spline teeth and involute serration teeth, presents dimensions for splines and serrations of recommended pitches, also a methodical treatment of manufacturing errors and their effect on the fit between mating parts. Spline tooth dimensions cover a range from 2.5/5 to 48/96 pitch and from 6 to 60 teeth, while the serration tooth dimensions cover the full range from 6 to 100 teeth for 10/20, 16/32, and 24/48 pitches, and a more limited range of teeth in the 32/64, 40/80, 48/96, 64/128, 80/160, and 128/256 pitches. Inspection methods, types of gages used, also their function and selection, gage dimensions and tolerances, gage blanks, measurement with pins, measurement of spline and serration errors are dealt with in considerable detail. Formulas for dimensions and tolerances, and tables on basic tooth data and on measurements between and over pins are also included.

JIG BUSHINGS, B5.6—1941. (Reaffirmed 1949) $1.00
Dimensions for: Press-Fit Wearing, Renewable-Wearing and Liner Bushings.

KNURLING, B5.30—1958. $1.50
This standard specifies dimensional relationship between the knurling tool and stock and gives standard diametrical pitches for tools.

LIFE TESTS OF SINGLE-POINT TOOLS, B5.19—1946. (Reaffirmed 1953) $1.00
Shows how to evaluate performance of single-point tools made of material other than sintered carbides.

LIFE TESTS FOR SINGLE-POINT TOOLS OF SINTERED CARBIDE, B5.34—1956. $1.00
This test procedure for determining tool life covers grade, shape and size of tool, material to be machined, the shape and size of cut, the cutting fluid, and relationship between tool wear and cutting time.

MACHINE MOUNTING SPECIFICATIONS FOR ABRASIVE DISCS AND PLATE MOUNTED WHEELS, B.35—1957. $1.50
Establishes standards for location and size of bolt holes in steel disc wheels (machine face plates) and the mounting side of abrasive discs and plate mounted wheels. Twenty-seven illustrations supplement the text.

MACHINE PINS, B5.20—1958. $1.50
These dimensions are for hardened and ground dowel pins, straight pins, ground dowel pins (not hardened), taper pins. clevis pins, and cotter pins. An appendix gives drilling specifications for taper pins and a drill chart for the size of drill and number required.

MACHINE TAPERS, B5.10—1960. $2.50
This standard establishes American standard practice in the slope of self-holding and steep machine tapers, the dimension of this type of taper tool shank, and the corresponding dimensions for the taper socket in the spindle of the machine, including the dimensions of keyways. An appendix tabulates Brown and Sharpe tapers, and additional Morse tapers not included in the standard, also Morse stub tapers and Jarno taper data.

MARKINGS FOR GRINDING WHEELS, B5.17—1958. $1.00
Covering markings only, this standard establishes a symbol for each of the most essential characteristics of a grinding wheel and arranges them in uniform sequence.

MOUNTING DIMENSIONS OF LUBRICATING AND COOLANT PUMPS FOR MACHINE TOOLS, B5.28—1958. $1.00
Tables give specific mounting dimensions for motor-driven centrifugal pumps, centrifugal and geared pumps, centrifugal pumps (flange mounted type), gear and vane pumps and for mounting brackets.

MILLING CUTTERS, B5.3—1960. $3.00
Covering milling cutters of one piece construction, this standard describes, illustrates, and gives the principal dimensions of 24 types of profile sharpening milling cutters, five types of form relieved milling cutters. milling cutter tolerances, dimensions of keys and keyways for milling cutters and arbors, and dimensions and tolerances for weldon shanks.

PUNCH AND DIE SETS FOR TWO-POST PUNCH PRESS TOOLS, B5.25—1950. $1.50
These dimensions for back-post and diagonal-post sets cover die area, the die holder and punch holder thickness, shank diameter and lengths, guideposts and bushings, and removable punch holder shanks.

REAMERS, B5.14—1959. $2.50
Following a comprehensive glossary of reamer terms, tolerances and general dimensions are given for thirty-seven types of reamers including an extended series of high speed steel straight shank reamers.

ROTATING AIR CYLINDERS AND ADAPTERS, B5.5—1959. $1.00
Here are given the dimensions of ten sizes of air cylinders, the pull and stress data at 100 lb. square inch air pressure, the dimensions of four sizes of adapters, and the sizes of adapter screws and tapped holes.

SINGLE POINT TOOLS AND TOOL POSTS B5.22—1950 $1.50
Illustrates and defines classes of tools, their parts and angles at which they are used; gives dimensions of tool shank, tool post openings and tool holders.

SPINDLE NOSES AND ADJUSTABLE ADAPTERS FOR MULTIPLE SPINDLE DRILLING HEADS, B5.11—1954. $1.00
Here are the general dimensions of assembly and the detail dimensions of adjustable adapter body, set screw slot, adjustable extension adapters, adjustable adapter set screw and friction lock nuts, and spindle noses. Tolerances, finish and marking are specified.

SPINDLE NOSES AND ARBORS for Milling Machines, B5.18—1960. $1.00
Contains dimensions of the spindle noses, ends of arbors and adapters, and draw-in bolt ends.

An important new addition to this 1960 document is the table of dimensions of the spindle nose with large flange. Revisions incorporated affect certain of the essential dimensions given in the 1958 standard.

SPINDLE NOSES for Tool Room Lathes, Engine Lathes, Turret Lathes, and Automatic Lathes, B5.9—1960. $2.50
Tables give dimensions for Type A, B, D and L spindle noses, as well as for mating backs of chucks, face plates and fixtures. Also given are dimensions of gages for checking the important dimensions on these spindle noses, the backs of chucks, face plates and fixtures to insure interchangeability between parts made by different manufacturers.

In this 1960 revision tolerances for length of pilot and depth of pilot bore for Type A-1 and B-1 spindles have been decreased slightly, pilot bore diameters for some sizes of chucks, and corresponding gage dimensions changes, and the method of dimensioning radial hole locations revised.

STRAIGHT CUT-OFF BLADES FOR LATHES AND SCREW MACHINES, B5.21—1949. $1.00
Gives dimensions for the height, length, and thickness of the approved four types of blades, and includes sketches to show the optional shapes for cut-off blade stock.

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Tables show dimensions for T-slot, their tongues and cutters and for inserted and reversible tongues and tongue seats. Tolerances are specified.

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It describes the various tap styles, includes nomenclature and definitions, and presents complete specifications of the standard taps, including new styles such as oversize machine screw taps, helical flute taps, and spiral point taps with short flutes. It also lists the tap recommendations for all classes of Unified and American screw threads.

TWIST DRILLS, B5.12—1958. $2.00
Included in this standard are nomenclature, difinitions, sizes and tolerances of two flute straight and tapered shank twist drills, combined drills and countersinks, selected sizes of millimeter drills, screw machine length drills, jobbers length and taper length drills. Drill sizes and their decimal equivalents are also listed.

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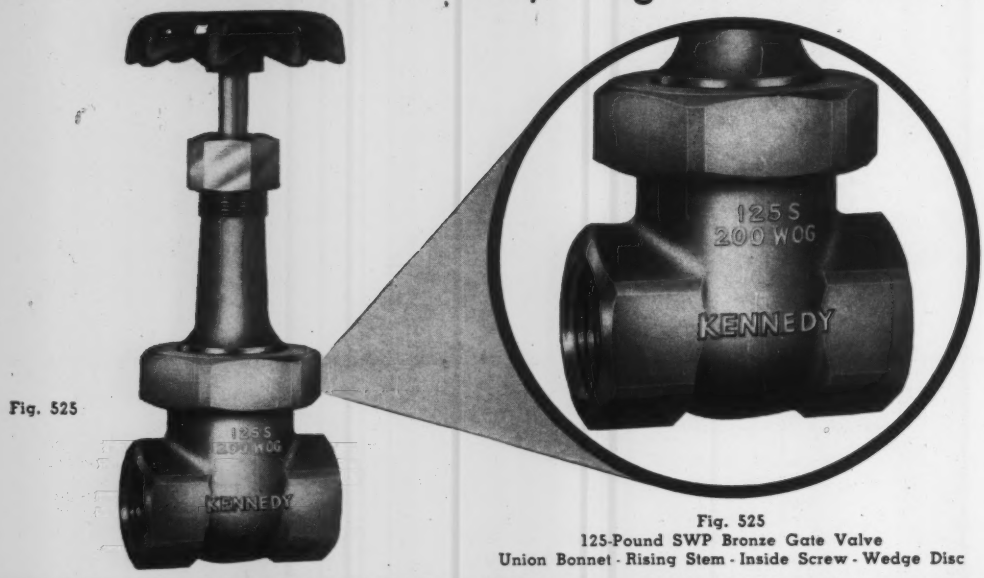
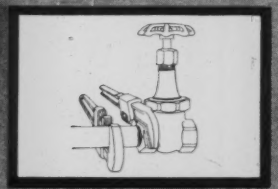
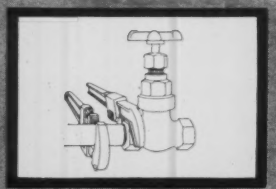


Fig. 525

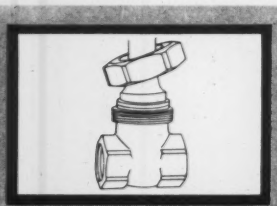
Fig. 525
125-Pound SWP Bronze Gate Valve
Union Bonnet - Rising Stem - Inside Screw - Wedge Disc



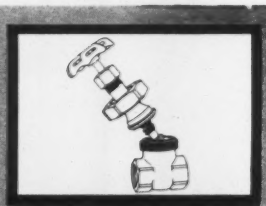
KENNEDY'S wider hex ends are blended into the body, making the body and hexes one rugged unit. Thus extreme wrench pressure is absorbed through the entire rigid valve body.



On conventional valve body, hex ends protrude from the body and are connected by thin body wrists. This area, under severe wrench pressure, can distort and cause disc seating trouble.



Kennedy's Union Bonnet permits repeated dismantling for cleaning or inspection and reassembly without danger of distortion to the valve. The bronze-to-bronze construction makes a tight union for tight, leak-proof operation.



Union Bonnet Fig. 525 can be easily disassembled into its component parts to installation in otherwise inaccessable places in existing lines or in new installations where space is limited.

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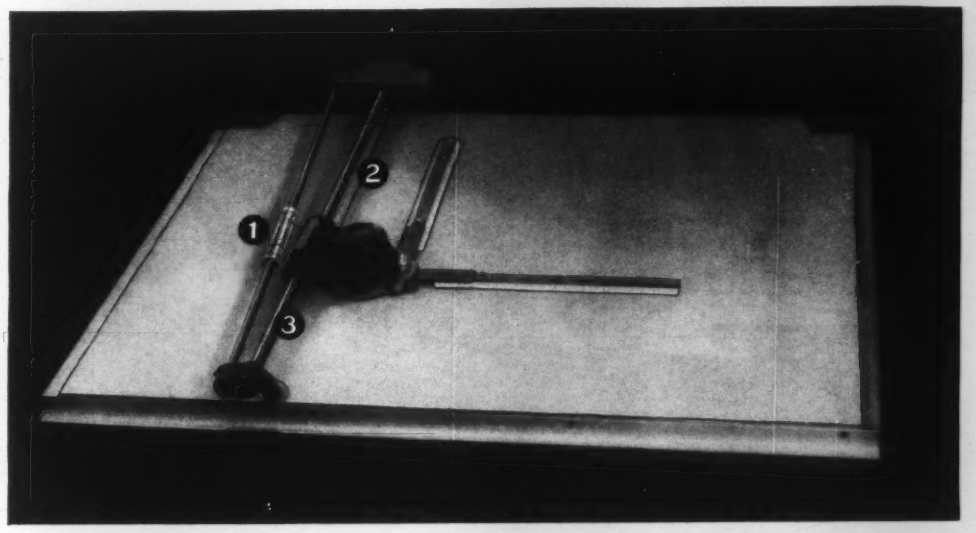

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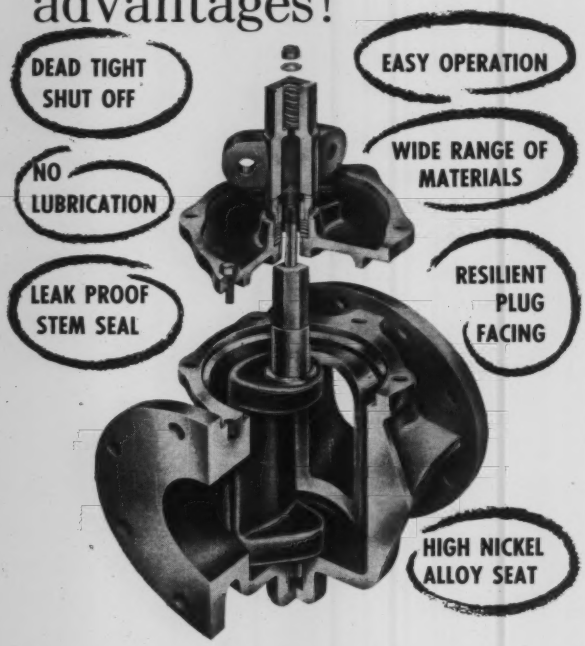

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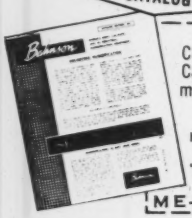

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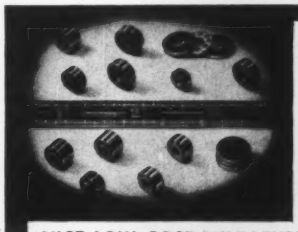

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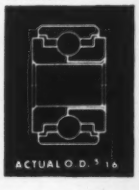

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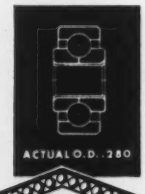

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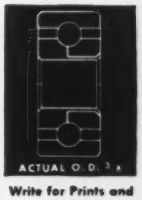

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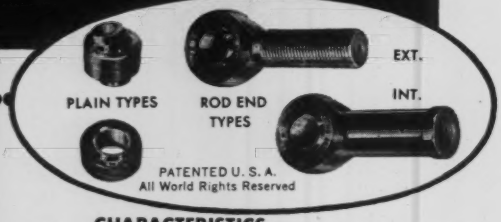

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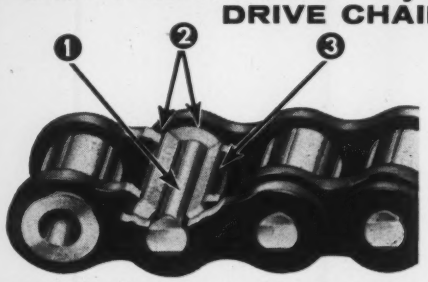

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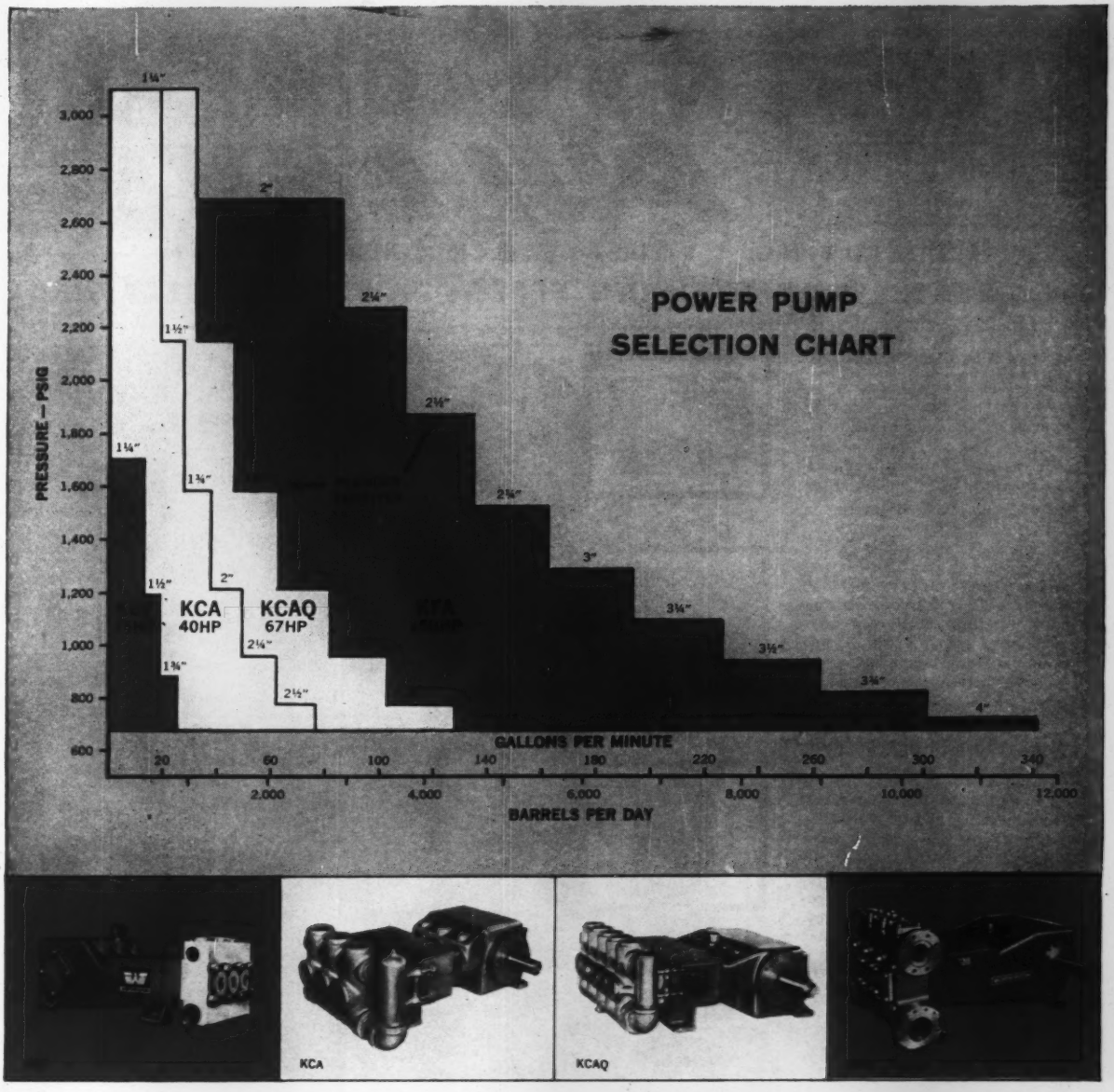


NEW PUMPS EXTEND RATINGS

...to make Worthington your lowest cost high-pressure pump

This is the first public announcement of two new Worthington high pressure, reciprocating pumps. With nominal ratings of 15 and 150 hp, they complement existing pump lines rated at 40 and 67 hp. All are horizontal designs which save you up to 53% on initial cost.

These four pumps—each available in several interchangeable plunger sizes—allow you to buy the most economical amount of pump for your particular application. Should you require pumps of more than one rating, you save money on spares because many parts are interchangeable in the Worthington line.

Some of the applications where Worthington high pressure pumps can save you money include hydraulic presses and shears, steel mill roll balance, die casting, boiler feed service, descaling, cleaning and washing, fog spraying, hydrostatic testing, and chemical processing. For more information write Worthington Corporation, Section 32-8B, Oil City, Pa.

WORTHINGTON

STEPHENS-ADAMSON PULLEYS

CURVE CROWN® BY STEPHENS-ADAMSON

FEATURING "SQUEEZELOCK" HUB DESIGN

FOR GREATER BELT TRAINING EFFECT... REDUCED BELT WEAR

STURDY RIM CONSTRUCTION

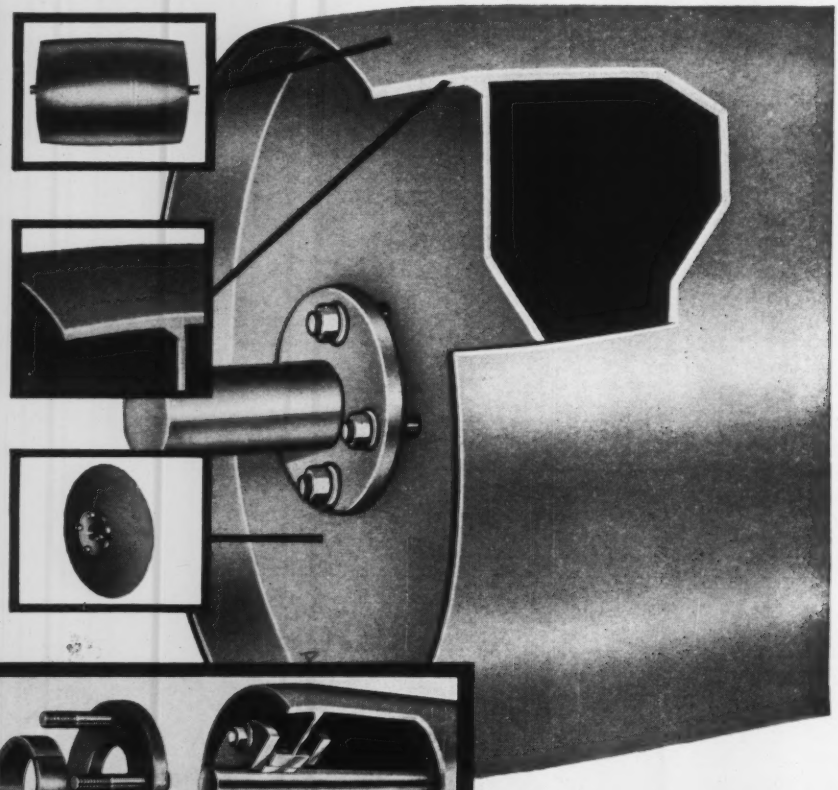
Pulley rims are made of one-piece construction, formed absolutely round under hydrostatic pressure. The only seam is machine-welded both inside and out to insure 100% penetration of welds.

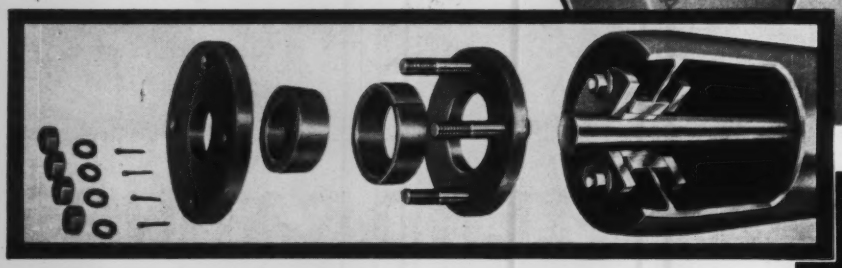
CURVE CROWN® DESIGN

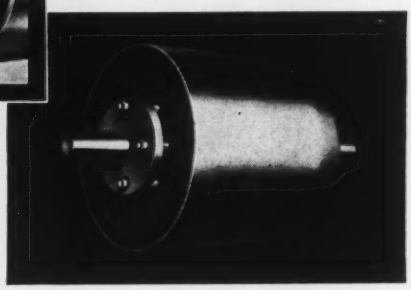
Curve Crown on outer ends of rim accurately formed. Revolutionary design eliminates conventional center peak — high point for belt stretch and wear —while increasing belt training effect more than 100%.

ACCURATE END PLATE ASSEMBLY

End plates are machined on both the O.D. and I.D. to insure concentricity between the bore and the outer rim. They are pressed into position for tight fit-up and submerged arc-welded for maximum efficiency.







"SQUEEZELOCK"® HUB Revolutionary design of "SQUEEZELOCK" Hub provides gripping power for full torque transmission without the use of keyways and eliminates distorting loads against pulley end plates. Two split tapered bushings are wedged against shaft and pulley end plates by two independent hub plates which are squeezed together by tightening four large diameter bolts.

Write for Bulletin 558

S-A

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OPPORTUNITIES

positions open • positions wanted • equipment, material, patents, books, instruments, etc. wanted and for sale • representatives • sales agencies • business for sale • partnership • capital • manufacturing facilities

ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

RATES: Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $4.00 a line. $2.00 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display advertisements carried in single column units of multiples of one inch at flat rate of $40.00 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

POSITIONS OPEN

RESEARCH ENGINEER

A fine career opportunity for an M.E. who possesses the theoretical knowledge and unusual capacity for creative accomplishments to originate useful and unique steam specialty equipment. For full information write to T. B. Palmer,

Personnel Director, YARNALL-WARING CO.
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Two Year MSA-Accredited College of State University of New York seeks

INSTRUCTORS IN TOOL DESIGN and MACHINE DESIGN

with ME or IE background. Excellent opportunities for professional development; new, growing campus. B.S. required. Master's degree and/or teaching experience desirable. Starting salaries to $7500 depending on experience, background, etc. Write full details to Mr. Benjamin Davis, Head, Mechanical Dept., Mohawk Valley Technical Institute, Utica, N. Y.

MECHANICAL ENGINEERS

Los Angeles

The Bechtel Corporation earnestly seeks high caliber applicants who are desirous of becoming established with a progressive and leading organization with opportunities in design and construction field engineering. Those in the organization participate in an incentive program which affords opportunity, added benefits and security.

Minimum of 6 years' experience in design of steam power plants or heavy industrial projects. Areas of work include process design, equipment specifications and procurement, and instrumentation and automation. B.S. degree required.

Relocation allowances cover moving costs plus transportation reimbursement for you and members of your family. Send confidential resume, including present and required starting salary, to Technical Recruiting Division. Personal interviews will be arranged for qualified candidates.

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See Advertisements on Following Pages

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VALVES and mechanisms for critical high-pressure, high-temperature services in the growing marine, petroleum, process and power fields—including nuclear power.

CONTACT J. M. Evan, Edward Valves, Inc., subsidiary of Rockwell Manufacturing Company, 1200 W. 145th St., East Chicago, Indiana.

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Challenging opportunity for research minded engineer with degree in either mechanical or electrical engineering. Should have a minimum of four years' experience in the design of small mechanical appliances for mass production. Position requires planning and conducting projects of major scope with a minimum of supervision and coordinating the work of other engineers and technicians assigned to the project. Please submit resume and salary requirements to:

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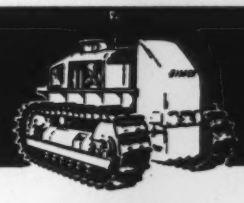
American-Standard
Research Department
Plumbing and Heating Division
834 East Broadway
Louisville 4, Kentucky



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Work includes layout and design of heavy machinery for construction and mining.

Permanent positions open, for those qualified, with one of the nation's fastest growing heavy machinery manufacturers.

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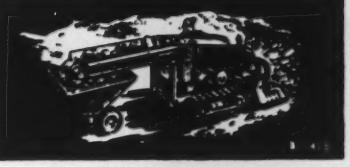
Send Complete Information and photograph to Dept. SX8

THE EIMCO CORPORATION
P. O. Box 300. Salt Lake City 10, Utah



PLASTIC MATERIAL SPECIALIST

Plastics Evaluation Center, Department of Defense establishment at Picatinny Arsenal, Dover, New Jersey, is seeking an individual with a thorough knowledge of mechanical and physical properties of plastic materials used in missiles and aircraft. Applicant must have ability to prepare reports on selected aspects of plastics technology. Considerable travel. Graduate mechanical, aeronautical or chemical engineer preferred. Salary to $10,635. Liberal leave policy, other benefits. Transportation expenses, including movement of household goods, paid for selected applicants who reside more than 20 miles from worksite. Position is in the Career Civil Service. Send resume to

Civilian Personnel Office
Picatinny Arsenal, Dover, New Jersey

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Expansion of U.S.I.'s plant and development engineering activities present real growth opportunities in chemical process industry. Midwestern locations.

DEVELOPMENT ENGINEERS—(Project, Mechanical and Design)—for planning, installation, and evaluation of equipment for experimental projects related to mechanical processes.

MAINTENANCE ENGINEERS—for maintenance planning and control.

INSPECTION ENGINEERS—for testing and inspection of corrosion resistant coatings and material.

MATERIALS HANDLING ENGINEER—for design and application of materials handling systems, unit containers, and packaging equipment.

Send resume to—Professional Employment Manager,

U. S. INDUSTRIAL CHEMICALS CO.
Division of
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99 Park Avenue **New York 16, N. Y.**

MECHANICAL ENGINEERS

Bausch & Lomb

There are several openings for Senior Design Engineers in the Product Design sections of our company.

These openings are permanent positions requiring the ability to take Mechanical Design responsibility from specifications to a saleable product. Products involved are mechanical-electrical-optical in nature. A Mechanical Engineering Degree and at least 6 years of mechanical design experience is required. No optical or electrical background is necessary, but would be helpful in certain openings.

These positions require board design, coordination of customer requirements with Electrical and Optical Designers, supervision of detail draftsmen, assistance to shop during construction and assembly as well as testing and development work.

Those who can qualify and are interested in real design responsibility are invited to submit a resume to: Mr. H. A. Frye, Professional Employment.

Bausch & Lomb

INCORPORATED

18 Bausch Street

Rochester 2, New York

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Exceptional opportunities exist for qualified engineers and scientists to work on challenging, diversified research programs in the following areas:

Mechanical properties at extremes of temperature and loading rates

Analysis of brittle behavior

Glass fiber drawing and extrusion techniques

Ultra-High pressure behavior

Wear, Friction and attrition experiments

As a Foundation staff member you will be joining a mature, independent research organization with a staff of over 600 engineers and scientists contributing to a wide variety of military and industrial research programs. Our environment is midway between academic and industrial research and offers many unique opportunities for personal and professional growth.

Applicants should possess an advanced degree, preferably a Ph.D. in Mechanics, Physics or Metallurgy. Several years of experience in the areas outlined above are desirable but not necessary.

The Foundation offers competitive salaries plus liberal benefits including up to four weeks annual vacation. Please send resume to:

John F. Collins

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of Illinois Institute of Technology

10 West 35th Street

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These key positions carry increasing responsibility in a growing department serving rapidly expanding industrial and military markets for advanced systems involving:

- Hi-speed rotating and reciprocating machinery
- Compact process components and controls

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Responsible for design and development of machinery including supervision of groups responsible for the analysis, specification, application and testing of machinery and systems. Requires engineer with theoretical and creative design ability and famili arity with products of major machinery manufacturers plus 10 years' related experience.

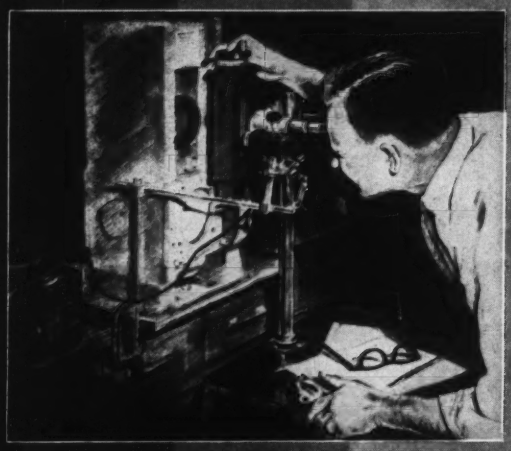
Manager Product Engineering

Responsible for groups involved in layout, design, prototype manufacture, cost reduction and quality improvement for newly developed products. Thorough background in machinery design is essential, knowledge of prototype techniques helpful. Engineering degree plus 8 years' related experience required.

Intermediate position for Development Engineer to plan and execute developmental programs involving new product analysis, design and test. Minimum of 3 years' related experience required.

Our company, a leader in its field, with increasing backlog of orders and bright prospects for broader markets insures maximum professional growth for qualified engineers. Well evaluated salary program, liberal benefits and relocation allowance.

Please submit resume including salary requirements to CA-7043, % "Mechanical Engineering"



Following pioneer achievements in reactor power plant developments, the Knolls Atomic Power Laboratory is now studying major problems in reactor and power plant simplification. Solutions to be achieved may considerably advance nuclear reactor applications.

Working on unique developmental problems at KAPL, engineers and scientists have access to an unusually broad range of specially-designed experimental and test equipment... as well as the advantages of inter-professional consultation with experts in a number of related fields. Advanced nuclear studies are available at both the Laboratory and nearby colleges.

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FOR NUCLEAR ENGINEERS AND SCIENTISTS

You are invited to inquire about openings in:

Mechanical Equipment Design / Control & Instrumentation Design / Reactor Design Analysis / Power Plant Test & Analysis / Reactor Physics / Nuclear Analysis / Coolant Technology / Computer Programming / Radiological Physics.

Please write fully in strict confidence to Mr. A. J. Scipione, Dept. 41-MK.U.S. Citizenship and appropriate engineering or scientific degree required.

Knolls Atomic Power Laboratory

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Outstanding opportunity in research and development for B.S. or M.S. graduate in Mechanical Engineering with a minimum of 5 years' design experience in the following areas:

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Textile Machinery

High Speed Machinery

Must be able to write reports and express self well. These positions offer a challenge to the engineer with imagination, initiative, and good technical ability.

Excellent employee benefits include tuition-free graduate study and liberal vacation policy. Please send replies to:

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10 West 35th Street
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With PhD in Mechanical Engineering and varied interests in the mechanical engineering field for experimental and analytical research to originate mechanisms, power and process equipment. 2–3 years' industrial experience preferred. Write, giving details, etc., to:

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Assistant to Vice President in Charge of Research

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Post Office Box 512

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While we cannot detail all of Hamilton Standard's product areas, there are stimulating assignments available in the broad fields of missiles and space systems, electron beam technology, electronics, ground support equipment, solar power generation and others. It is a company which is entering its most exciting era of growth and accomplishment . . . and can offer young men unusual engineering opportunities.

Add to the above, the attractive living conditions of beautiful Connecticut . . . one of the industry's finest company-paid graduate programs . . . the extensive facilities of United Aircraft Corporation . . . and you can appreciate why so many of your fellow A.S.M.E. members have found rewarding careers at Hamilton Standard.

For complete information and the brochure, "Engineering For You and Your Future", write Mr. R. J. Harding

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an organization dedicated to Scientific and Engineering Excellence

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Celestial Mechanics
Cam Dynamics
Theory of Packaging
Vehicle Dynamics
Shock Isolation and Damping Studies

The Foundation is a mature, independent research organization with a staff of over 600 engineers and scientists contributing to a wide variety of military and industrial research programs. Our environment is midway between academic and industrial research and offers many unique advantages.

Candidates should possess an advanced degree preferably a Ph.D. in Mechanics, Mechanical Engineering or Mathematics and have a proven record of achievement in research and deveolpment as evidenced by publications.

The Foundation offers a competitive salary plus liberal insurance and retirement benefits in addition to four weeks' vacation after one full calendar year of service. Our location offers excellent cultural and recreational opportunities.

If this is the unusual professional opportunity you have been looking for, reply in confidence to:

J. F. Collins

ARMOUR RESEARCH FOUNDATION

of Illinois Institute of Technology

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Chicago 16, Illinois

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Excellent position with our Central Engineering group in Chicago is now available for experienced engineer interested in long-range career opportunities, a variety of creative, challenging assignments, and complete responsibility for project development:

MECHANICAL ENGINEER, *experienced in design, estimating, supervision of the preparation of plans and specifications, negotiations with contractors and utility companies, project coordination between plant and engineering from planning stages to completed construction for industrial processing plants, equipment and facilities.*

This position provides attractive starting salary with liberal merit increases based on ability and initiative. A full program of benefits is available, including a company-sponsored educational program.

All replies confidential.

Send resume to: J. R. LYTLE

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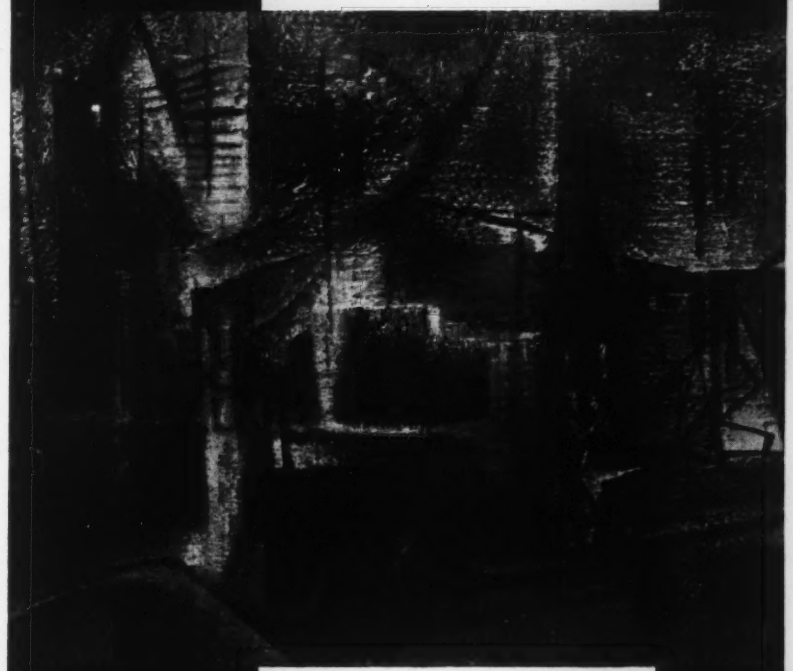

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Between an original concept and scientific achievement, the engineer, working with an unequaled array of experimental and test facilities at Los Alamos, makes significant contribution to space science.

For employment information write: Personnel Director Division 60-106

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OF THE UNIVERSITY OF CALIFORNIA
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A large expanding pharmaceutical company located in the Mid-West has an opening for a mechanical or chemical engineer in the Plant Engineering Department. This is an excellent opportunity to combine engineering with administration. Outstanding salary and company benefits. Send complete resume including salary requirements to **Personnel Department, Parke, Davis & Company, Detroit 32, Michigan.**

MAINTENANCE GENERAL FOREMAN to head plant maintenance department in a leading eastern steel foundry. Should have at least five years' experience in foundry or steel mill field and be well versed in modern day maintenance management techniques. Mechanical or Electrical Engineering graduate preferred but will consider others of proper qualifications. Position is one of real challenge, offers optimum opportunity and pays well. Send detail resume. Address CA-7048, care of "Mechanical Engineering."

DIRECTOR OF SPECIFICATIONS DEPARTMENT. Large Midwest consulting firm has immediate opening for capable individual with broad experience in specification writing for all branches of building construction work. Must also possess administrative ability. Send complete resume of educational background and experience, including personal qualifications and small photograph. Address CA-7039, care of "Mechanical Engineering."

Canadian West Coast—Ideal living area—resourceful EXECUTIVE ENGINEER with strong academic and administrative background. Responsibilities include code vessel and exchanger design, metallurgy, steel fabrication, foundry-forge operations, new products, sales—customer relations. Remuneration open. Interview arranged. Reply with resume. Address CA-7042, care of "Mechanical Engineering."

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MISCELLANEOUS

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Continued on Page 202

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BUSINESS OPPORTUNITIES

Continued from Page 201

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Substantial New England manufacturer of precision machined metal parts seeks to acquire additional product lines that can be produced in his plant and sold to industrial customers. Should be mechanical components or assemblies requiring high precision manufacture. Established product lines having demonstrated saleability preferred, but will consider new products having protected status and strong growth potential. Funds immediately available to purchase product lines or businesses meeting these requirements.

We are retained and compensated by this client. Inquiries invited from principals. Brokers recognized. Communicate in confidence with: Mr. Paul Field, Vice President, Business Incubation Laboratory, Route 7, Wilton, Conn., POrter 2-5551.

For Reference

A 24-PAGE LIST OF ASME PUBLICATIONS

is included in the

1961 MECHANICAL CATALOG

Copies of this List are obtainable from

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Publication-Sales Dept.

29 West 39th St., New York 18, N. Y.

BJ Boiler Feed Pumps

Quality *costs less* in the long run!

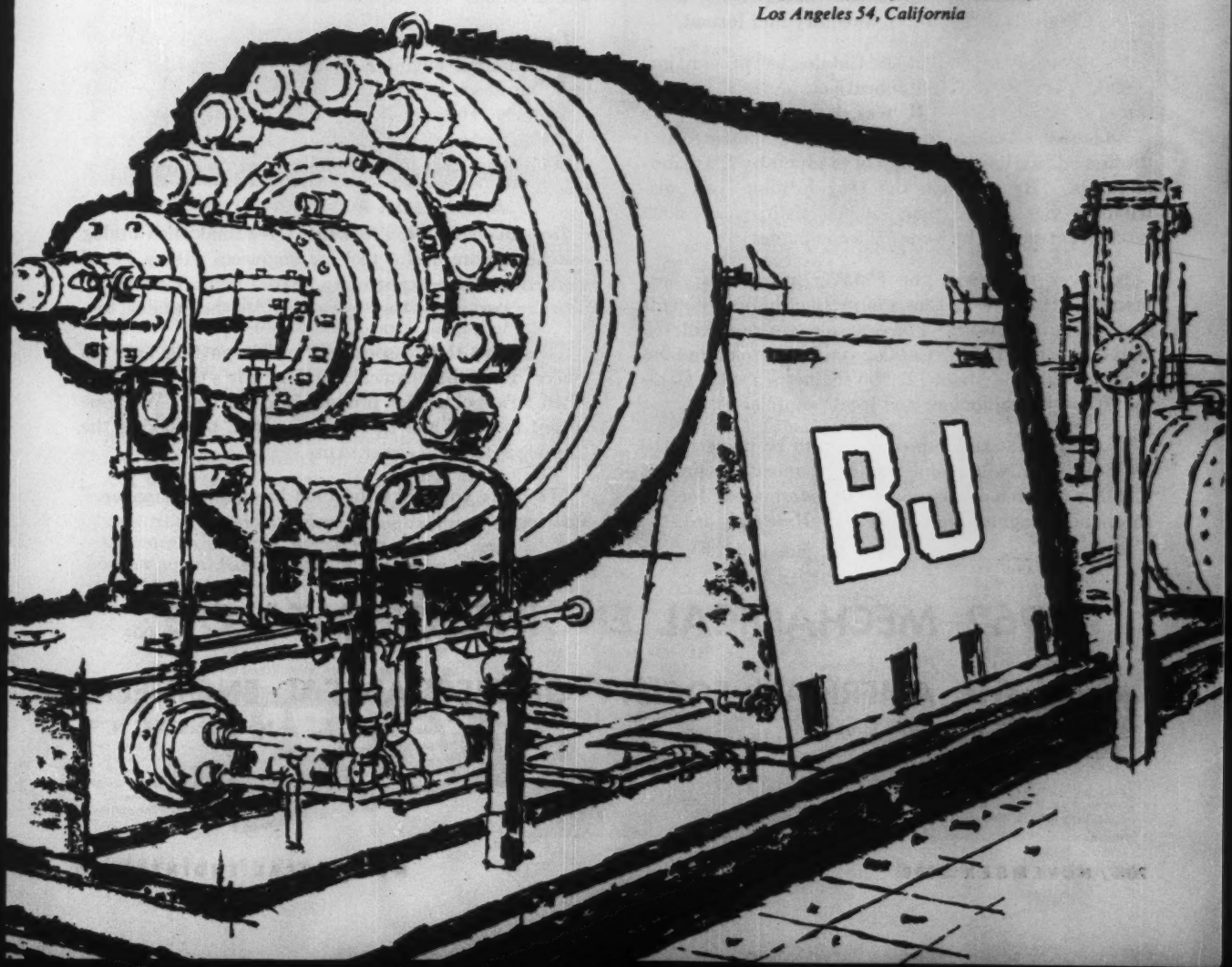
Reliability is the only real "bargain" you can afford in a boiler feed pump. Reliability that comes from the basic quality built into a pump, and the reliability that assures long, continuous performance under all conditions.

At BJ, quality is a full time job. Trained personnel with long experience in building quality pumps are combined with the latest facilities, equipment and special techniques. The result is a line of boiler feed pumps to meet the higher speeds and temperatures, greater capacities and higher pressures required of modern boiler feed service.

BJ Quality does cost less in the long run!

Baltimore Gas and Electric Company *adds four more BJ Double Case Boiler Feed Pumps to 22 already installed. One new 7200 HP unit will deliver 3035 GPM with 3290 PSI discharge pressure at 342°F.*

BYRON JACKSON PUMPS, INC.
SUBSIDIARY OF BORG-WARNER CORPORATION
P.O. Box 2017 A, Terminal Annex,
Los Angeles 54, California



WHY ARE WE PUTTING AN "ENGINEER" IN MECHANICAL CATALOG?

Beginning with the 1962 Edition of Mechanical Catalog, we'll be calling it the Mechanical *Engineers'* Catalog. The name change is being made to reflect better the use of the Catalog by ASME members, and also to emphasize the improvements that are being made in the Catalog's distribution, directory and format.

You probably know that the Catalog has been an important part of ASME Publications for some time—since 1912, in fact. It was known then as the "Condensed Catalogs of Mechanical Equipment," and the first edition has 480 listings of products by 220 manufacturers. By contrast, the 1961 Edition—just distributed—has more than 50,000 listings, in 6000 product categories, by some 3500 companies.

So, over the years, the Catalog has grown enormously. It is now *the* source of product information for mechanical engineers. For example, we've calculated that each edition of the Catalog is referred to more than 4 million times. About 123,000 engineers use the Catalog to specify equipment and locate suppliers.

We hope that the improvements to be made in the 1962 Edition will make the Mechanical Engineers' Catalog an even better source of information for the mechanical engineering profession. Here they are:

Increased distribution: Each year recently we've had more requests for the Catalog than we've had copies. We hope to have enough next year by raising the printing to 20,000 copies. Circulation will still be restricted to individuals who request the Catalog.

Improved product directory: The requirements of the mechanical engineer change pretty rapidly. Each year, he needs information in different, new, product categories. He wants to know about any new products. We're going to revise the Catalog's Product Directory to make it as up to date as possible. This job is beginning now.

Improved Catalog format: We think the Catalog will be a more useful tool for engineers with a bit of modernization in typography, layout and organization. So we're working on the "eye appeal" of the Catalog, too.

Those are the reasons why we're putting an "engineer" in the Mechanical Catalog. He's there already, when he's looking for product information. We hope to put more of him there, more often, by making the Catalog better and easier to use.

We think you'll like the 1962 Mechanical Engineers' Catalog.

1962 MECHANICAL ENGINEERS' CATALOG

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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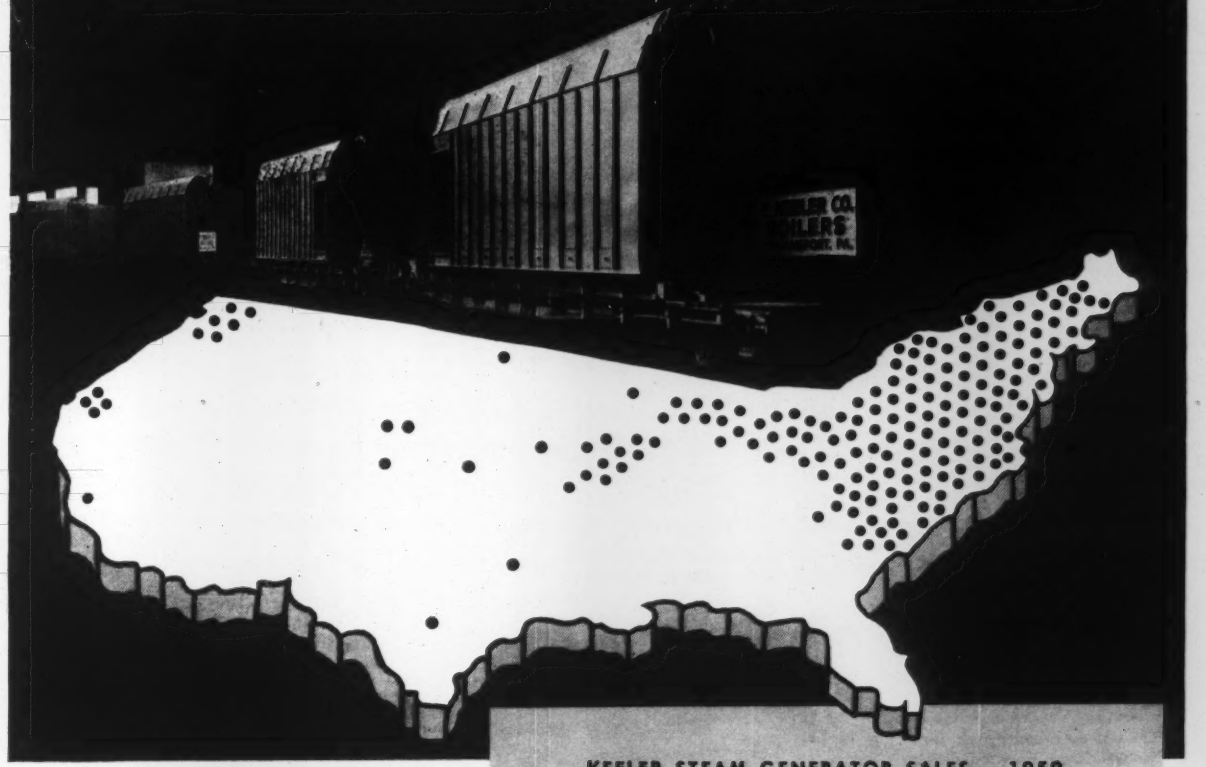

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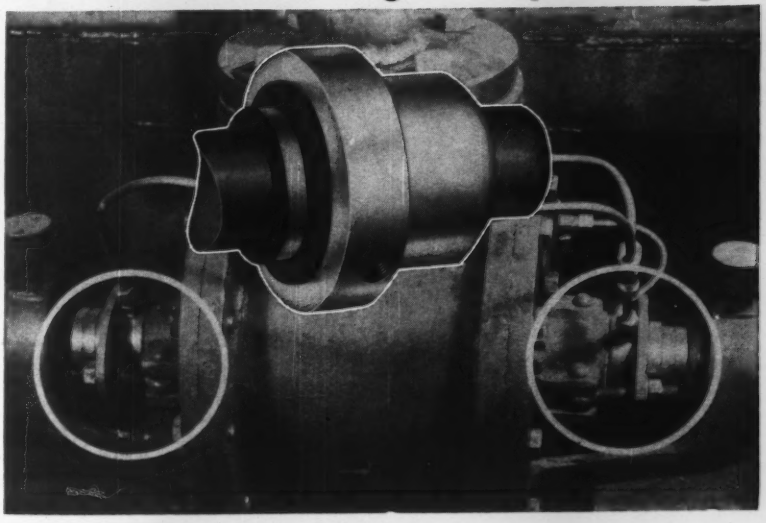

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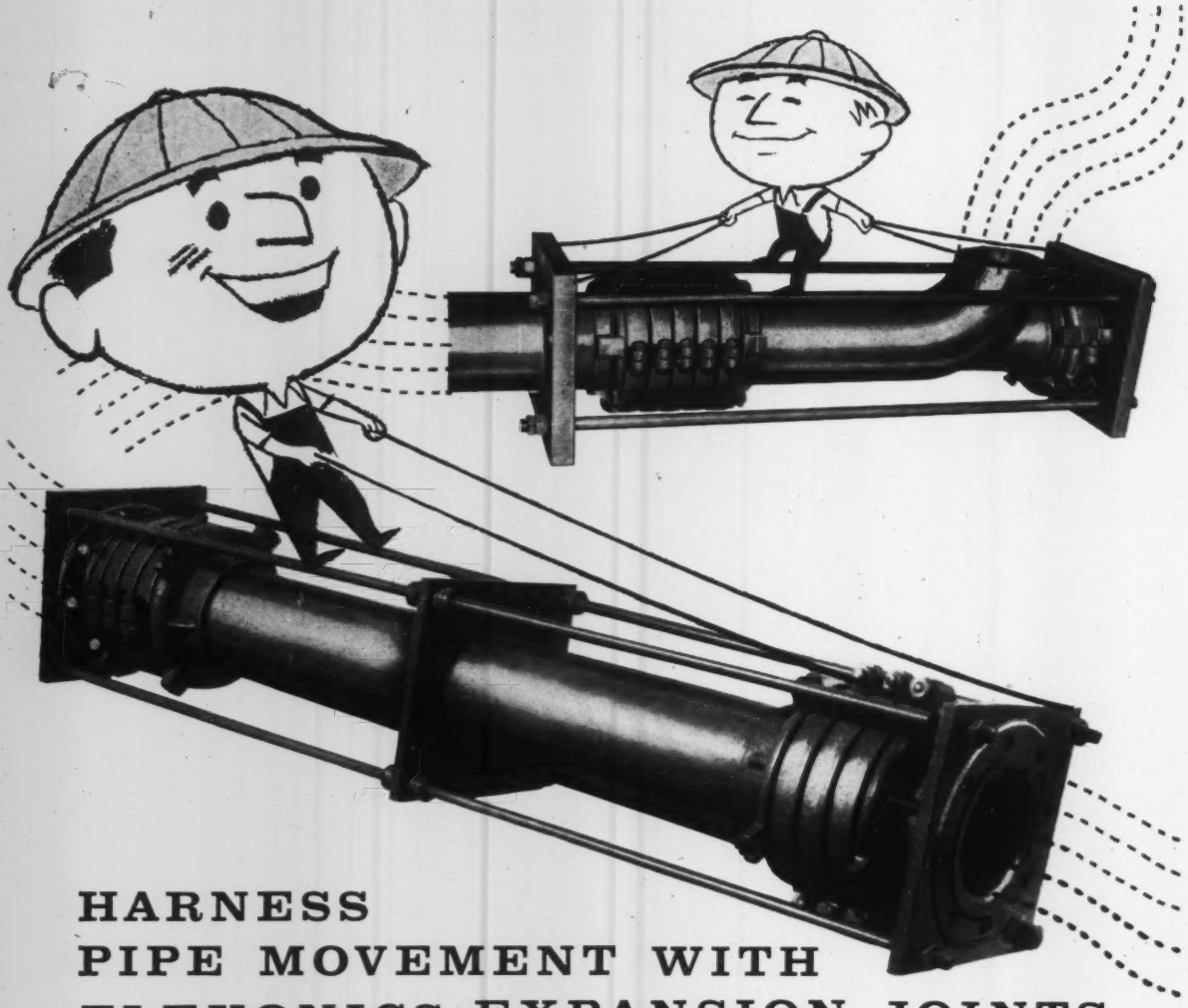

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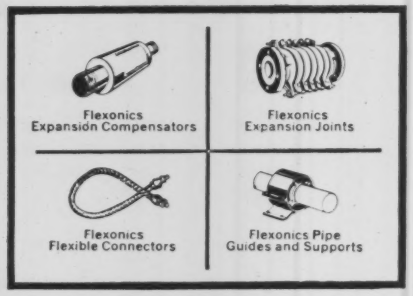

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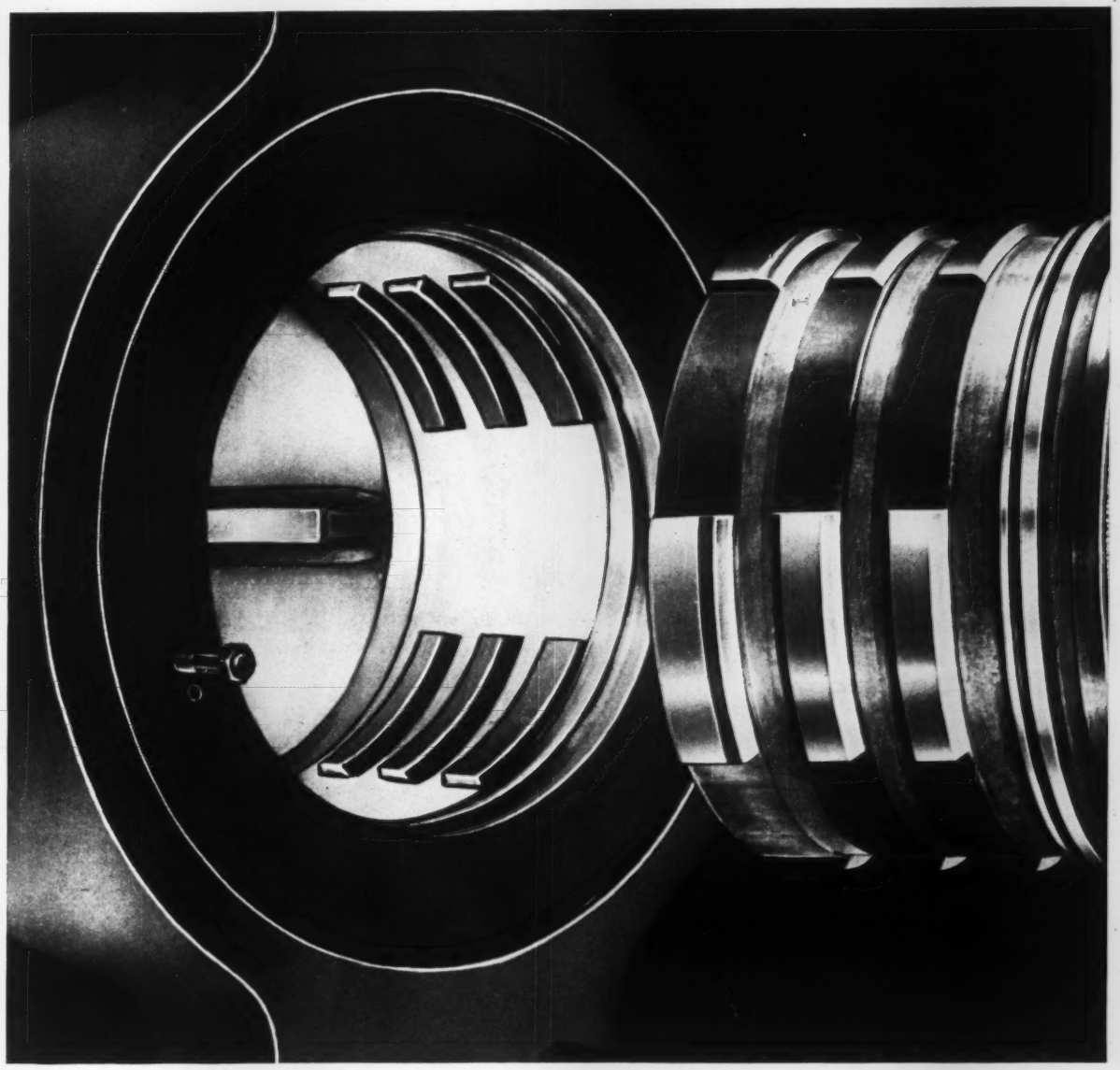

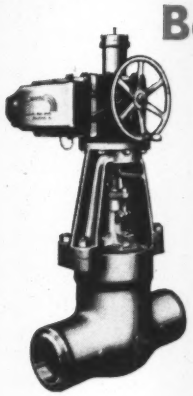

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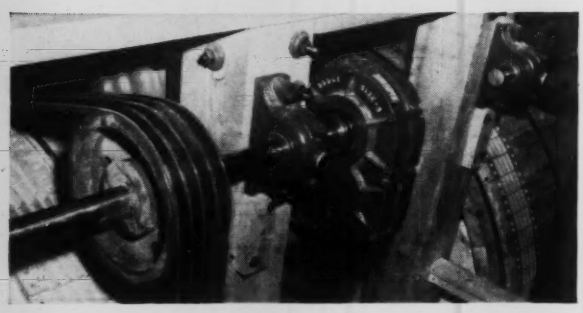
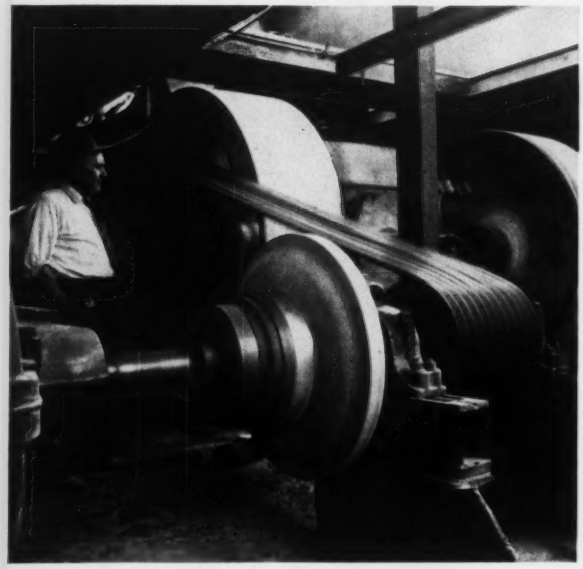
L-360-58

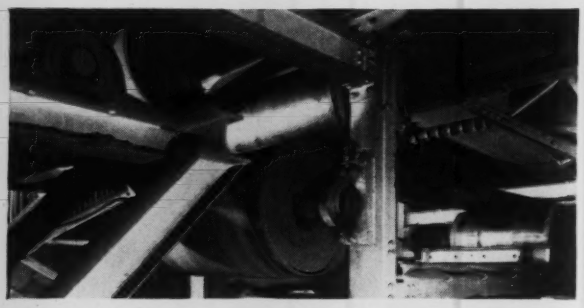
How Dodge pillow blocks with Timken® bearings give longer life with less maintenance



1. Two 2 7/16" Dodge Special Duty pillow blocks equipped with Timken® tapered roller bearings, support the line shaft driving six by eight foot tanning drums. The tapered design of Timken bearings enables them to take both radial and thrust loads in any combination.



2. The crusher at a trap rock and asphalt plant runs faster, gives more production now that Dodge Double Interlock pillow blocks on Timken bearings are installed. The Timken bearings in these blocks give full-line contact between rollers and races for greater load carrying capacity.



3. The Timken bearings in All-Steel Dodge pillow blocks must stand up under adverse operating conditions found when sintering metals. One major advantage of Timken tapered roller bearings is their ability to hold housings and shafts concentric, thus keeping lubricant in, dirt and dust out.

The photo at right shows the Dodge All-Steel pillow block Timken bearing equipped. The specially designed bearing has a tapered bore with self-aligning spherical outer surface—never needs adjustment.

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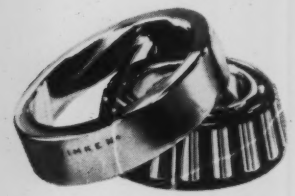

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